NPS-IJWA-99-004

COORDINATION OF FLEET BATTLE EXPERIMENTATION AND JOINT EXPERIMENTATION PROGRAMS

RESULTS FROM EXPERIMENT ECHO

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The Institute for Joint Warfare Analysis
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Monterey, California

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OUTLINE

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Section I. EXECUTIVE SUMMARY

This document reports the results of a project to obtain information from Fleet Battle Experiment (FBE) Echo that addresses Joint Experimentation (JE) concepts. Although there is no one-to-one correspondence between FBE and JE concepts, data captured during FBEs can, with appropriate processing, apply to JE needs.

The project has been a success. Initial work identified overlap between the two sets of concepts to define which data should be extracted. Since that step, both FBE-E and JE concepts have been modified, reducing the effectiveness of the overlap identification. As a consequence, the main method used to extract JE appropriate results has been concept "thread pulling". The steps taken were:

process Echo data to determine major operational points
pull appropriate results to address JE concepts (in body of this report)
extract significant JE results (in this Executive Summary)

These Executive Summary results are abbreviated descriptions. The codes attached to the results below refer one to the complete statements within the reported FBE-E results.

Attack Operations Against Critical Mobile Targets

1. Unmanned Air Vehicles are of high value in sensing targets. (AT-2, FTP-6)

2. A mobile C2 vehicle proved effective and did not require resources for protection as is needed for a fixed installation. (AT-1)

3. We don't know how to do deconfliction. (PE-2)

4. A Joint Interface Control Officer for management of differing service links greatly enhanced information dissemination. (FDP-8)

5. The organizational change to a Full Dimension Protection was effective. (FDP-1)

<u>Joint Interactive Planning</u>

1. Reliable networked communications are essential for Distributed Collaborative Planning.

2. Common operations/tactical decision aids enhance updating situational awareness.

3. Distributed Collaborative Planning enhanced situational awareness and provided reachback capabilities.

Rapid Decisive Operations

1. Embarkation of the Maritime Inshore Undersea Warfare Unit van extended organic and inorganic sensor ranges. (AT-1)

2. Deconfliction requires further investigation. No methods currently address latency. (PE-2)

3. Naval surface precision fires weapons are not useful in urban canyons. (PE-3)

4. Full dimension protection operationalized through an FDP cell enhanced force protection in an asymmetric threat littoral environment. (FDP-1)

5. The FDP Cell/LAWS terminal/PE fires team combination greatly decreased some time critical target timelines. (FDP-10)

6. Changes in tactics that compensate for arc and range of fire and improved identification methods are needed. (AT-3)

7. Organic Launch Profile Mission Planning tool accomplishes Tomahawk mission planning much quicker than ashore feeds.

Common Relevant Operations Picture

1. Utilization of the UAV for detection, identification, and targeting had remarkable value. (AT-2)

2. The LINEBACKER concept proved its capability to provide JTAMD. (FDP-2)

3. Video feeds from the UAV FDP watch team could be cognitively combined with additional COP information.

4. A Joint Interface Control Officer for management of differing service links greatly enhanced information dissemination. (FDP-8)

5. Real-time feed of environmental data and real-time feed of WMD indications/ warnings/analysis are needed for command management of WMD. (CM/CMO-3)

Adaptive Joint Command and Control

1. Command relationships between FDP, the JTFC and joint operations need to be further defined. In this experiment there was considerable ambiguity in the precise distinction of the command relationships implied by FDP centralized capabilities and roles. Consequences for battle-group organization and joint forces C2 are highly interrelated in this concept. (FDP-11)

2. Use of AVENGER in a TAMD role by the Full Dimension Protection cell is an example of adaptive C2.

Section II. PROGRAM METHODOLOGY

FBEs are conducted approximately twice per year. The objectives for these experiments are established by the Maritime Battle Center and the Fleet which conducts the exercise. For FBE-Echo, this process resulted in creating five experiment concepts:

- Asymmetric Threat
- Full Dimension Protection
- Precision Engagement
- Anti-Submarine Warfare
- Naval Fires

Within each of these concepts there was developed a set of hypotheses which were to be experimentally tested. The hypotheses are listed in Section IV.

Hypothesis statements were written that enabled the development of experimental measures. These measures guide development of the data capture plan and provide an understanding of what information will be available for analysis. On this basis, one can determine what contribution the experiment will be able to make to JE needs.

The JE program has evolved a set of initiatives which will guide future experimentation:

- Attack Operations Against Critical Mobile Targets
- Future Collaborative Information Environment
- Joint Contingency Force Operations
- Common Relevant Operational Picture
- Adaptive Joint Command and Control
- Interoperable Combat ID

These initiatives are broken down into issues, which are listed in Section IV.

There is not a one-to-one correspondence between FBE concept hypotheses and JE initiatives, but there is a great deal of overlap between them. The first step in the process was to identify those cases where the planned data gathering in Echo could contribute to advancing the JE initiatives. This identification is listed in an overlap matrix in Section IV.

The Echo results were obtained from the information gathered from the experiment independent of any consideration of JE needs, after which those needs were addressed. This was not done by simply regrouping the Echo results, but by combining them, or segmenting them in new ways so that generalized initiative statements could be made.

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Section III. DATA ARCHIVAL AND RETRIEVAL

Logging data during an experiment is straightforward, archiving it is not. The difficulty lies in archiving the data in such a way that it can be retrieved to meet a wide range of purposes. For example, one may wish to examine a particular concept (JE or FBE): C2 performance, logistics, weapon effectiveness, etc. Each of these require that the data be tagged in such a way that one can "pull" the appropriate data from the archive. This requires an extensive set of tags. The tagging system described below has been developed for FBE needs, and can be augmented to meet JE needs. It is being tested and is not yet operational.

Fleet Battle Experiment data are of many types, which are logged in different ways, and it is a challenge to relate various data to each other to obtain a coherent picture of an operations which can be analyzed. The archiving system described here has been developed to facilitate associating related data into logical operational groupings and to develop cause and effect time and action sequences, leading to valid concepts conclusions.

Echo data consist of mainly subjective observations and the times at which they occur. The contexts within which data occurred are needed. For our purposes, contexts are:

- the concept being tested,
- the experiment pillar (somewhat redundant with concept), and
- the MSEL with which the data is associated (of limited use for Echo).

The data produced during an experiment are of two basic types: 1) the status of systems and 2) action events. Both types of data are archived with the same coding system.

Data archiving is done with analysis needs in mind. In particular, analysis requires that one can do the following:

- group sets of events into logical processes,
- identify the logical sequence of events and/or processes that make up an operation, and
- identify events that are initiators for processes or other events.

These identifications allow one to construct what are commonly referred to as "Operation Threads". A Thread is a set of events that can be identified as belonging to the same operation. Note that an event can belong to more than one thread.

There is some flexibility in the way events are grouped into Threads, as long as cause and effect are preserved. The way Thread building is done depends on the analyses needed because a particular analysis will lead to a logical grouping of events, whereas a different analysis may require a different grouping. The key to data archival is to have it contain sufficient information that one can do whatever associations into processes and trigger-response cause and effect that are needed. Taking this into account, we have constructed the data tagging scheme

Additional information about what is meant by a process is needed. What we refer to as a process has robustness from operation to operation, such as sensing, C2, information fusion, etc. A process is a sequence of events, not necessarily fixed, e.g. decision process events will change if one uses a different command and control structure. It is useful to construct processes because what is produced is an "object" that can be represented by a set of parameters. Using the process of agglomerating or decomposing data into object blocks has the same utility as doing this for systems. Having a minimal needed number of objects to deal with simplifies analysis, and simplifies comparison between different operational configurations.

As noted above, the data consist of events. Each event is given one or more tags when it is archived. The tags used for the data contain two pieces of information: the "Class" of the event and the "Data Type". The Class identifies a category, such as communications, sensing, information about platforms, etc. The Data Type identifies a specific characteristic about the event, such as it identifies system status, a decision made, transmission of information, etc. Within each Class the data is segmented into Data Type.

The Classes and Data Types are listed below, along with codes for each in parentheses.

	Class	
Communications (C)	Platforms (P)	Red Forces (RF)
Sensors (S)	Network (N)	Red Operations (RO)
Weapons (W)	Command & Cntrl (C2)	Red Weapons (RW)
Targets (T)	Common Oper Pict (CP)	

	Data Type	
Mission (Mis)	Detection (Det)	Battle Damage Ass. (Bda)
Configuration (Cfg)	Identification (ID)	Information Sent (Iout)
Status (Stat)	Controlled By (Ctl)	Information Received (Iin)
Location (Loc)	C2 Event (C2)	Prioritize (Pri)
Underway (Uwy)	Assignment (Asn)	Real Time Failure (Fail)
Current Ops (Ops)	Contact Report (Crpt)	

These codes are used to enter data into an Ethnograph relational data base.

The data are archived with the tag, which is a combination of the two codes [Class – Data Type]. The following are descriptions of the meaning of each tag. Not all of the 209 possible tags are listed. Some possible tags are not present, such as Sensor-Configuration because configuration refers to a grouping of objects, not a single object. The tags that are used are presented in Table 1. In many cases it is sufficient to present a single explanation for a Data Type, such as Status, because the explanation applies regardless of the Class. The set of tag explanations listed below suffice as a guide for both archival and retrieval of data.

The times at which data were recorded are important considerations. Not all data have definite times associated with them, but all data will have an archived time mark.

<u>Tag Explanations</u>

Any blue-Mis: is the mission the particular system is assigned.

Red-Mis: is the goal of Red operations based on intelligence reports, location of assets, interpretation of sensor observations, or the calculated effects of Red launched weapons if not intercepted.

Any-Cfg: is the way a system is "wired". It specifies the objects used to construct the system and their relations.

Any blue-Stat: is the status of systems or sub-systems. Normally this will report system up or down but in many cases it reports portions of the system which are down and for which a work-around has been made, yielding a new configuration.

> Multiple Code Note: It is not only possible, but likely, that some events will have more than one code. Status is a perfect example. If a sub-system failure necessitates a work-around, the result is a new configuration and system status. Thus, this event would have associated with it the codes Fail, Cfg, and Stat.

Red-Stat: is the assumed status of Red forces or weapons based on intelligence reports or interpretation of sensor observations.

Any-Loc: is the location of an object, force, or action. These data should have a definite time mark associated with the location.

Any-Uwy: is the time at which a particular object, departs, is launched, etc.

Any-Ops: is the particular operation a platform or forces are undertaking, such as an Aegis ship in the Linebacker mode. For Red forces it is the assumed operation that is underway.

Any-Det & ID: are detection and identification events by sensors, normally of Red forces, but Blue are also included. It is possible to have detection with no identification, but the reverse is not possible. There are definite times associated with the detection and identification. These events occur by observing targets, with sensors, which are on platforms, then communicating the information. Thus the data will appear in the C, S, T, and P Families.

Any-Ctl: identifies the organization that currently controls an asset. The time at which control was passed may or may not be identified, if so a definite time should be recorded.

Any-C2: is a command and control event which results in an action or affects a system. This category is very broad, with the intent to capture all C2 decisions which affect all other families, e.g. assigning a weapon to a target, changing COP structure or dissemination, sending a platform to an area, etc.

Any Blue-Asn: are assignments of sensors, weapons, or platforms to particular tasks. An assignment is preceded by a C2 decision, and is a separate category to enable capturing the time delay between the decision and the action.

RW-Asn: is the assumed assigned targets of Red weapons due to their location and/or calculated impact points after launch.

Any-Crpt: are object contact reports. The contact and report can be made before an ID or assignment of another asset closer examination and ID. Thus, inclusion of these data allows one to identify decisions and time delays associated with sensor observations.

Any-Bda: are various types of battle damage assessment events. They range from sending a sensor to do BDA, to communicating results, to the decision whether or not to reengage a target.

Any-Iout: identifies the source of information, its type, from where it was sent, when it was sent, and the medium through which it was sent.

Any-Iin: identifies the type of information, when it was received, and where it was received.

Any-Pri: is an event which establishes priorities for sensors, weapons, targets, or platforms. These are steps in the engagement process and recording them establishes the time sequence.

Any-Fail: is the failure of, or reporting of, the failure of any system.

CP-Any: includes various types of information about the common operating picture. This information is partially redundant with other data, but the COP is of significant importance and warrants a separate category.

Table 1. FLEET BATTLE EXPERIMENT DATA LOGGING CODES

		CLASS								RED FC	
DATA TYPE	Code	Coms (C)	Sens (S)	Weap (W)	Targts (T)	Platfs (P)	Netwk (N)	C2 (C2)	COP (CP)	Forces (RF)	Ops (RO)
Mission	Mis		S-Mis		T-Mis	P-Mis					RO-Mis
Configuration	Cfg	C-Cfg				P-Cfg	N-Cfg	C2-Cfg	CP-Cfg		
Status	Stat	C-Stat	S-Stat	W-Stat	T-Stat	P-Stat	N-Stat	C2-Stat	CP-Stat	RF-Stat	
Location	Loc		S-Loc	W-Loc	T-Loc	P-Loc				RF-Loc	
Underway	Uwy			W-Uwy		P-Uwy					
Current Ops	Ops					P-Ops				RF-Ops	
Detection	Det	C-Det	S-Det		T-Det	P-Det				RF-Det	
ID	ID	C-ID	S-ID		T-ID	P-ID				RF-ID	
Controled By	Ctl		S-Ctl	W-Ctl		P-Ctl					
C2 / Decision	C2	C-C2	S-C2	W-C2	T-C2	P-C2	N-C2		CP-C2		
Asssignment	Asn		S-Asn	W-Asn		P-Asn					
Contact Rpt	Crpt	C-Crpt	S-Crpt							RF-Cpt	
BDA	Bda	C-BDA	S-Bda		T-BDA					RF-Bda	
Info Sent	Iout	C-Iout	S-Iout		T-Iout			C2-Iout		RF-Iout	
Info Receivd	Iin	C-Iin			T-Irec					RF-Iin	
Prioritize	Pri	C-Pri	S-Pri	W-Pri	T-Pri			C2-Pri			
Real Time Fail	Fail	C-Fail	S-Fail				N-Fail		CP-Fail		

Section IV. FBE-ECHO / JOINT EXPERIMENTATION OVERLAP

For sake of completeness we list here the FBE-Echo concepts and hypotheses, the Joint Experimentation Issues and sub-issues, and the overlap matrix. This material can also be found in Ref. 1, along with a list of the measures and groupings of the overlapping hypotheses/measures and issues/sub-issues.

IV-1 JOINT EXPERIMENTATION CONCEPTS AND ISSUES

Concepts are identified by the J9 designator Exx and their included issues by Ix.

E01: Attack Ops Against Critical Mobile Targets
- I1: What levels of command are authorized to engage?
- I2: How is the OODA loop enabled to operate more quickly?

E02: Future Collaborative Info Environment
- I1: What is our capability to support the creation of a database of near real-time information concerning events in the AOR?
- I2: What is our capability to support the establishment of timeliness criteria (<1 hour) for recognition and inclusion of info in the database?

E03: Joint Contingency Force Operations
- I1: What technology(s) improved the survivability and supportability of early entry forces?

E05: Common Relevant Operational Picture
- I1: How do Marine Corps systems contribute to the COP?
- I2: What is the most efficient balance of "push" and "pull" dissemination?
- I3: How will each Service's common tactical picture interface with the COP?
- I4: Will the common operational picture facilitate flatter command structures and delegation of decision making or will it invite micro-management by senior commanders?
- I5: How can the common operational picture realistically accommodate information sharing with NGOs and PVOs?

E06: Adaptive Joint Command and Control
- I1: Will the degree of connectivity, bandwidth, and knowledge available tempt senior commanders to usurp lower-level decisions and micro-manage?
- I2: Assuming a new joint force architecture is a means with the potential to accelerate
  info flow and decision making, will it also increase the span of control, thus altering command relationships and organizations?
- I3: Will the advances in technology allow for the elimination of an echelon(s) of command, their associated headquarters, and support requirements?
- I4: What is the optimum balance of information push/pull for the 21st century?

E07: Interoperable Combat ID.

I1: How is CID of troops and equipment provided to prevent fratricide in an urban setting?

IV-2 FBE-ECHO CONCEPTS AND HYPOTHESES

The concepts are grouped under the following broad categories;

A. Maritime Dominance
B. Precision Engagement/Ring of Fire
C. Full dimension Protection
D. Civil/Military Operations
E. Naval Command and Control

Under each of these is a further breakdown of the concept into concept categories, labeled Ax, etc. Each is shown below. The hypotheses within each concept category are labeled Hx.

A. **Maritime Dominance**

A1. <u>Countering the Asymmetric Threat</u>

H1: Combat swimmers can be detected by Mobile Inshore Undersea Warfare Unit (MIUWU) and other swimmer detection systems and countered by coordinated ops of the Port Security Unit.

H2: Attached mines can be located more quickly by hand-held sonar.

H3: Networked multi-sensor surveillance and response forces in layered defense can counter asymmetric small boat attacks

H4: Networked multi-sensor surveillance and response forces in layered defense can counter attacks from personal watercraft.

H5: Networked multi-sensor surveillance and response forces in layered defense can counter night attacks on anchored HVU by covert rubber boat with Sea Shadow drop-off.

H6: Networked multisensor surveillance and advanced detection and management systems can mitigate effects of asymmetric WMD attacks from low, slow flying aircraft.

H7: Networked multi-sensor surveillance and response forces in layered defense can counter night attacks on the HVU by anti-ship missiles launched from a truck which exits a known holding area and proceeds to a launching area in the hills above the harbor.

H8: Intel prep of the battlespace, advanced sensors, and networked control of CG PSU by MIUWU will allow more effective positioning and employment of the PSU against the variety of asymmetric threats.

A2. <u>Network Centric Undersea Warfare</u>

H1: A collaboratively developed ASW search plan improves overall search effectiveness.

H2: The use of identical, hi-fidelity models and associated databases by all ASW participants improves the overall understanding of the overall search plan and individual sensor performance. Additionally, the use of a common model allows "drill-down" into the factors affecting performance.

H3: Time integration of the tactical undersea picture provides additional significant information for all ASW echelons compared to the tactical picture alone.

H4a: The undersea tactical picture provides sufficiently timely positional and operational information for blue force submarines to safely enable dynamic weapons exclusion zones around blue force submarines.

H4b: An ASW Joint Engagement Zone will allow more successful prosecution of an adversary submarine than the current exclusive waterspace management policy protecting blue force submarines.

H5: The sensor network and contact management capabilities of the ASW network provides an improved ability to "finger-print' and conduct all source overt or covert tracking of high interest WHITE shipping.

B. **Precision Engagement/Ring of Fire**

B1. National Assets and UAV for Fires in Support of Forces Ashore in Urban Canyons

H1: Navy UAVs in conjunction with other assets can provide effective warning and supporting fires to USMC urban operations against enemy actions beaches/streets/buildings, enemy vehicular movements, enemy infiltration in urban neighborhoods, enemy WMD in industrial area, night urban targeting, vehicular target of interest, interdiction of USMC operating areas, fixed targets of WMD interest, China Lake range targets, targets related to WMD vignette beyond Concord.

B2. Airspace Deconfliction

H1: Dynamic deconfliction techniques can provide control in limited but diverse operations.

B3. ELB Experimentation

H1: Coordination of a variety of sensors with the attacking aircraft can provide mission-essential information to the cockpit for strikes within the window of a time-critical targets and also aid the pilot in finding and hitting the target.

B4. Supporting Arms Coordination Center Exercise (SACCEX) Experimentation

H1: Digital information from LASER/GPS range-finders will allow effective GPS-guided NSFS at ranges of 18K yards using the LAWS-AFATDS-BCS linkage.

C. **Full Dimension Protection**

H1: The addition of information from civilian in-place systems can significantly improve the fused picture of air and surface conventional and asymmetric threats.

D. **Casualty Management**

D1. Comparison of casualty prediction and logistics models (MAT, FORCAS, SHIPCAS, CASEVAC)

H1: No single model contains all of the features desired for all sizes of operation but one stands out as the most appropriate for the battalion-sized operation.

D2. Medical Collaborative Logbook

H1: Medlog is a convenient system for theater level situational awareness and daily management.

D3. Multi-lingual Interview System/DARPA One Way (DOW) Computer.

H1: The DOW provides an acceptable medium for eliciting vital information from non-English speaking casualties when no local language capabilities are available.

D4. Theatre Medical Core System (TMCS)

H1: TMCS provides patient tracking on a near real-time basis and also summary OPORD Annex Q casualty management information.

D5. StatRef as field reference library on CD-ROM.

H1: StatRef is an easy to use reference to the latest procedures and treatments.

E. **Civil Military Operations**

E1. Civil Military Operations Doctrine Development.

H1: Doctrine for managing a domestic Civil Military operation through the CMOC can be developed.

E2. Consequence Management of Toxic Releases

H1: There are effective civil-military responses to the two toxic releases.

E3. Virtual Work Space

H1: A Virtual Work Space can improve the coordination between the JMC and the CMOC.

F. **Naval Command and Control**

H1: A combined Blue-Green ECOC will enhance collaboration between the staffs and allow better understanding of the commander's intent, a more complete perception of the total battlespace and more rapid staff action preparation.

IV-3 OVERLAP BETWEEN FBE-E HYPOTHESES AND JE ISSUES

The following table shows the overlaps between the Joint Experimentation issues and the Fleet Battle Experiment hypotheses using a two-number prioritization scheme. The first number of the prioritization is applicability of that particular hypothesis to the JE issue, and the second number is the expected data quality for that particular purpose. For the first number-second number, 1 is the highest applicability-best quality and 3 is the lowest-poorest. A vertical line above or below a cell indicates that one or more cells have been merged.

JOINT EXPERIMENTATION CONCEPTS

		E0 1		E0 2		E0 3	E0 5					E0 6				E0 7
FBE-E		I1	I2	I1	I2	I1	I1	I2	I3	I4	I5	I1	I2	I3	I4	I1
Maritime Dominance																
Assym Threat	H1					2-2	1-3		1-3							
	H2					2-2										
	H3		|			1-2	1-2		1-2						1-2	
	H4		|			1-2	1-3		1-3						|	
	H5		|			1-2	1-3		1-3							
	H6		2-2			1-2	1-2		1-2							2-3
	H7	1-3				1-2	1-2		1-2							
	H8			1-2	2-3	1-2	1-2		1-2						2-2	2-3
NC-USW	H1						1-2		1-2			1-2	2-2	2-3	2-3	
	H2			1-2	1-2	1-2	1-3					1-2	2-2		2-3	
	H3						1-2					1-2	2-2			
	H4a															1-1
	H4b															
	H5			1-1	1-1	1-1	1-3		1-3						2-3	1-3
PE/Ring of Fire																
Nat Ass-UAV	H1	1-2	1-2	1-2	1-2	1-2	1-2	1-2				1-2			1-2	1-2
Air Deconf	H1					1-3							2-3			1-1
ELB	H1	1-3	1-3			1-3									2-3	
SACCEX	H1		2-2			1-2										
Full Dim Prot	H1			2-1	2-1	2-1			3-1							
Civ/Mil Operations																
Doctrine	H1										2-2					
Conseq Manag	H1			2-3	2-3											
Virtual WS	H1								1-2		1-2		2-2			
Naval C2	H1											1-3	1-3	1-3	2-3	2-3

Table 2. Overlap matrix of FBE-E hypotheses and JE concept issues.

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V. FLEET BATTLE EXPERIMENT ECHO RESULTS

The complete results from FBE-Echo are extensive and can be found in Ref 2. Here we list the summary results from each concept. It is from these results that we extract those findings applicable to Joint Experimentation.

Note that the concepts listed here are not an exact match to those listed in Section III-2, because Echo hypothesis modifications occurred as the experiment approached. This makes it more difficult to extract Joint Experimentation applicable results. The overlap matrix presented in Section IV-3 is a guide but not directly applicable.

The Echo results presented here come directly from Reference 2. For each concept we list major points, a description of the concept, and summary results. The Reference also includes complete listings of the observations associated with each concept.

V-1 ASYMETRIC THREAT

Major Points

- Embarkation of the MIUW Van extended organic and inorganic sensor range and allowed it to be used in the Littoral Zone of Interest without having to establish a secure rear area for MIUWU protection

- Utilization of the UAV for detection, identification, and tracking had remarkable value. High quality imagery of mobile targets was almost continuously available to the Harbor Defense Commander , Full Dimension Protection Cell and others. A combat swimmer was detected by the UAV while at altitude.

- Changes in tactics that compensates for arc and range of fire and improved identification methods are needed to prevent fratricide of HVA defenders and take into account possible collateral damage both over water and ashore.

Concept

Mission Concept: Harbor Defense, Maritime Pre-positioned Force Protection (protection of High Value Assets (HVA) at sea or at offshore anchorage or in port) against asymmetric threats from combat swimmer attacks is a requirement in the asymmetric environment.

Operations Methods: Employ a boat with specialized sensors and flexible command and control capability to protect against asymmetric threats in port, at offshore anchorage, or in other littoral areas.

Use response forces in a layered defense to include armed patrol boats and Explosive Ordnance Disposal units under the command of the specialized boat to increase speed of response and defensive posture.

Use real time intelligence, surveillance, and reconnaissance data to achieve greater battlespace situational awareness to improve speed of command.

System Solutions: Slice boat, MIUWU (Maritime Inshore Undersea Warfare Unit) Van, Swimmer detection system, and Hand held sonar

Summary

MIUWU maneuverability was enhanced by being placed aboard an afloat unit (termed the SLICE boat). By being embarked the MIUWU was less vulnerable as a moving target and was able to relocate as needed, extending organic and inorganic sensor range. Embarkation also allowed the use of MIUWU in the Littoral Zone of Interest without having to establish a secure rear area for MIUWU protection.

However, it was also determined that some equipment did not function well on this mobile platform. A result from this experiment is that MIUWU equipment should be evaluated for use while embarked on a mobile platform. The evaluation should consider all expected mechanical issues, electronic functions and environmental effects. For example, contact with the MIUWU was lost when the SLICE boat accelerated. There were inherent satellite targeting problems associated with a moving platform, as well as stabilization issues with other equipment. Solutions to these problems would provide the JTF with an enhanced MIUWU capability, to be tested in a future FBE.

Defenders aboard an anchored high-value asset were confused about which boats to shoot when high-speed boats attacked the high-value asset and defending PSU boats engaged the attackers. Inshore Boat Unit (IBU) and Port Security Unit (PSU) assets need some form of IFF or tactic to separate themselves from the threat vessels.

Fratricide is a risk when the fields of fire for the IBU's and PSU's overlap during maneuvering to intercept incoming attackers. Fire directed from the high value unit against attackers may also be dangerous to a defending IBU or PSU not easily identified or too close to an attacking boat. This risk is multiplied in poor visibility due to weather or at night. The PSU's attempted to use the tactic of staying close to the HVU and using overlapping fire on attackers. Another tactic, "peeling off" away from attacking craft to allow the HVA to bring its defensive fire to bear was also attempted by the PSU's. Both tactics were demonstrated to be problematic in practice, leading to a post experiment definition of need for some form of electronic identification to be instantly recognized by both the HVA and defending units. A time-sensitive targeting concern is that there is a very limited time in which defending crews can respond to attacking fire. Indications and warnings provided by a system which also provides identification information might decrease the overall response time by reducing the identification time.

An overriding hypothesis for FBE Echo was that network-centric concepts could be used to advantage in the asymmetric environment. Indeed, from the MIUWU perspective this unit was able to use multiple sensors to detect, track and identify a jet-ski attack on a HVA at anchor in the littorals. However, from the PSU perspective there were problems related to the receipt and effectiveness of commands between the MIUWU and controlled units. Examination of message traffic loading during this portion of the experiment revealed very high message rates. However, PSUs noted in post-experiment questionnaires that very little of these communications were useful in their conduct of HVA defense and that there were limited pre-attack warnings. Poor communications between the MIUWU and PSU's contributed to the C2 difficulty and was evidenced by several of the boat drivers' inquiry as to whether jamming had been conducted by the OPFOR. Specifics related to this problem need to be defined. However, a more readily identifiable contributor to C2 problems the lack of headsets for PSU's to maintain two-way communication between themselves or MIUWU. Holding a handset while executing high-speed maneuvers is problematic at best. In post-experiment interviews PSU crews reported they reacted to self-identified in-theater threats, followed by execution of pre-planned tactics. The extent to which MIUWU provided situational awareness to defending units seems to have been limited due to a combination of difficulties. A limited objective experiment may help identify specifics of C2 system problems and provide insight to deconfliction tactics and technology.

As part of the WMD scenario, EOD-HQ tested CD-ROM analysis software and communications paths to provide this information to the field. Included in this communications system were TECDIV at Indian Head (?), the WMD cell aboard Coronado, EOD-HQ itself and the Response Team. The system was to provide historical images of WMD systems and a record of communications related to the present situation. The capability of this system could not be fully tested or demonstrated due to the lack of a satellite channel and poor RF conditions. Further complicating the WMD problem, Response Teams did not have chemical sniffers or other technical means to assess the threat on sight. Identification of these additional technical means and further tests are indicated, along with improvement in the C2 architecture to support connectivity between the multiple sources which are necessary to assess and neutralize the threat.

Swimmers attack against the HVA is another possible threat in the asymmetric environment, and defense against this threat was tested in FBE Echo. As part of a swimmer defense, a hand-held sonar has been developed but was unavailable for this experiment. Without the added technology, PSU's adopted a tactic of dropping overlapping grenade concussion patterns, but these actions did not result from swimmer detection, indications by any sensor or direction by the HVA or MIUWU. This part of the experiment highlighted the need for further testing of new equipment and tactics to counter this type of threat.

During early formulation of concepts of operations in response to asymmetric threats for the San Francisco Bay phase of the experiment, use of defensive helicopters in a ready five state would provide a major defensive capability. An initial definition of the concept was modeled using the General Campaign Analysis Model (GCAM). Model analysis demonstrated that if the helicopter was not airborne at the time of threat designation the helicopter would not be positioned to effect intercept. The impact of this early analysis was that helicopters were then not tested in the defensive tactic weapons for these scenarios.

V-2 NETCENTRIC ANTISUBMARINE WARFARE (NCASW)

Major Points

- NCASW increased force situational awareness through distributed advance search plans
- Reliable networked communications are essential for Distributed Collaborative planning (DCP) in NCASW
- Common tactical decision aids and common understanding of the DCP process are enhance the update of situational awareness required for NCASW

Concept

Mission Concept: Maritime dominance relies on the traditional air, surface and subsurface superiority in the battlespace.

Operations Methods: The employment of Network Centric ASW (NCASW) will improve the commanders ability to assess balance mission objectives with the risk imposed by adversary submarines.

System Solutions: Distributed Collaborative area search planning JEZ/JAZ

Technical Solutions: WeCAN, IMAT, SPPEDS

Summary

The objective of network centric undersea warfare is to create a fully integrated undersea warfare capability contributing to full dimensional protection for forces in and beyond the Joint Area of Operations (JOA). In FBE-Echo network-centric anti-submarine warfare the goal was to use distributed collaborative planning (DCP) for multi-sensor search and prosecution. An ASW cell with improved connectivity, standardized models and databases was stood-up for training and contingency operation planning in FBE-E and conducted both planning and execution during the associated Limited Objective Experiment (LOE). This was the first FBE in which undersea warfare played a major role.

Concepts being tested in the undersea warfare cell involved the availability of enhanced C4I systems to provide high data rate connectivity, fusion of a detailed underwater picture with surface and air pictures, use of search planning and assessment tools, battle management tools, and remote sensor management tools. Sensor systems providing passive acoustic, mono-static active acoustic, multi-static active acoustic, non-acoustic detection plus environmental characterization were required to complete the undersea picture. Finally, weapon systems for shallow water ASW, for loitering and in support of distributed sensors, mine neutralization, and non-lethal options are necessary in this asymmetric environment.

For FBE-E not all of these capabilities were present, but were simulated by the ASW anchor desk as necessary to conduct the experiment. The anchor desk was designed around enhanced connectivity to ships, submarines, aircraft, national assets, environmental information resources, sensor platforms and other command centers. Search plans from the anchor desk were distributed to affected units updated with local environmental information, assessment of compatibility with other assigned warfare duties and assessment of risk to that unit.

The ASW portion of the Anchor Desk was tasked to: Develop and evaluate search plan options to support the overarching campaign missions. Develop, maintain and distribute adversary submarine threat data and cueing information derived from all surveillance systems. Fuse, maintain and distribute coherent tactical and operational pictures of the undersea battlespace. Evaluate the effectiveness of completed search operations leading to an assessment of the current asymmetric submarine threat to the overarching campaign missions. Consolidate and analyze in-situ environmental data collected by dispersed sensor platforms. Cache and distribute oceanographic and meteorological data, imagery, etc., to provide "one stop shopping" reach-back service to assigned/supported ASW forces. Manage the collaborative search planning process and the employment of remote sensor systems. Conduct "what if" analysis of ASW search and force employment plans to evaluate alternative courses of action.

V-3 PRECISION ENGAGEMENT

Major Points

- Laws demonstrated flexibility and ease of use. While the system was by no means fully exploited, it performed well for the functions utilized during this experiment.

- Deconfliction requires further investigation. DAMS was not successfully electronically interfaced to LAWS. Full implementation of algorithmic procedural deconfliction in LAWS may yield improvement over current methods and be more efficient than DAMS. Any deconfliction system requires an adequate visualization tool to be useful. No methods currently address latency issues.

- Naval Surface Precision Fires weapons currently in use or programmed are not useful in the Urban Canyons.

Concept

Mission Concept: Operate in the littoral, provide Naval Fire Support to place munitions on designated targets in a time constrained environment.

Operations Method: Employ sensor to shooter continuum versus fixed and mobile targets. Utilize Integration of imagery and targeting tools in support of reactive and deliberate targeting. Integrate the use of four dimensional near real time deconfliction in the execution of precision engagement. Conduct targeting and missile shots in a GPS jamming environment.

System Solutions: LAWS, DAMS, EFT, CCT, JSTARS, and ADSI

Technical Solutions: ISAR P-3 and Tactical UAV

Summary

This pillar continues experimentation for the "Ring of Fire" which has been a strong portion of all of the FBEs to date and also of the related "Vicious Blaze" and "Silent Fury" efforts which address more deliberate targeting processes. Its objective is to utilize Naval Fires of all types to allow the operation of Naval forces in an urban environment where there is no organized conventional threat but a significant unconventional threat including terrorists and infiltration units including weapons of mass destruction.

The overall goals are to explore three aspects of Naval Fires (NF):

Targeting NF in an urban environment including integration of multiple imagery sources and targeting tools including the isolation of USMC areas of operations from enemy reinforcement.

Sensor to shooter capability against both fixed and mobile targets particularly use of UAVs in permissive and non-permissive environments.

Responsive deconfliction of Naval and other fires.

The desired effect of these capabilities was to suppress enemy activity levels to those that can be dealt with by the relevant in-country forces and to allow maneuver with minimal losses by friendly forces at sea, in landing or ashore. Secondarily, adaptability of personnel to the functionalities of the various systems and the potential automation of the processes is of interest. To accomplish these objectives, a network of ISR sensors and of command & control and weapon fire control systems was built using actual and simulated systems. The Land Attack Warfare System (LAWS) was the cornerstone of the network and was located in command centers on the Coronado and on the shooter ships as well. Major information flows were the UAV pictures, other imagery , the Common Operating Picture (COP) and target data packages from the various mission planning systems.

1. National Assets, TACAIR and UAV Sensors for Fires in Support of Forces Ashore in Urban Environment

Based on actual and simulated cueing from HUMINT / national assets and Naval air platforms, plus the live UAV (the Pelican pseudo-Predator) tracking and spotting missions were performed. When appropriate, UAVs were tasked to locate, identify and track targets. Passing of specific threat information from the UAV control and fusion elements to the ashore units and shooters was evaluated. Integration of UAVs into overall surveillance planning was examined.

Initial Hypothesis: Navy UAVs in conjunction with other assets can provide effective warning and supporting fires for urban operations against the following threats:

Enemy actions beaches, streets / buildings - Monterey & SF

Enemy vehicular movements (Monterey to San Francisco)

Enemy infiltration in urban neighborhoods

Enemy WMD in industrial area
Night urban targeting
Vehicular target of interest
Interdiction of USMC operating areas
Fixed targets of WMD interest (Monterey and SF)
Actual range targets ñ TLAM & SLAM
Targets related to WMD vignette

Each of these activities generated real or simulated fire mission requests. Air and NSFS systems were tasked to support the missions. A deliberate (6 ñ48 hour) targeting exercise (Vicious Blaze) examined all-source imagery fusion, manipulation and dissemination for production of electronic target folders afloat. Silent Fury processes were planned on reactive targeting via TACRECCE for response under two hours.

Measures for this initial hypothesis are given below:

Measure 1: Responsiveness of targeting to mission requests: time to detect target and pass to shooters.

Measure 2: Ability to derive accurate target coordinates for point precision data base within engagement time windows.

Measure 3: Ability to build electronic target folders for major targets of interest including WMD-associated targets within time windows of opportunity.

Implementation: For Measure 1: Flew simulated A/C and national sensors to cue UAV operators to locate, identify and track hostile targets. Used simulation to maintain ground truth and support surveillance planning. Compared simulated results to real views for detectability. Consolidated and recorded timelines with LAWS for analysis. Maintained electronic logs of major results of flights and simulations. Provided a questionnaire to gain insights into difficulties of control of UAV operations and passing of information to affected units. For Measures 2&3 observers recorded processes used to obtain and manipulate information into target folders for evaluation by the shooters. Usability of the systems was assessed by a five-point subjective scoring of the features.

As anticipated, the range of target conditions above strained the capabilities to quickly respond with effective strikes.

The Precision Engagement portion of the exercise consisted of experimenting in how the Navy will support ground operations ashore with Naval Fires. This included new technology and new tactics, techniques and procedures. The three cells primarily involved with this evaluation were the Joint Strike Center (JSC), the USMC Enhanced Combat Operations Center (ECOC) and the Joint Fires Cell (JFC). The Joint Strike Center was primarily concerned with deliberate targeting at the strategic and operational levels. They used various sensing assets to collect imagery on potential targets for strike planning and the building of Electronic Target Folders (ETFs). The Enhanced Combat Operations Center was primarily concerned with reactive targeting to support ground forces ashore at the tactical level. Sensing assets were also used at this level to refine the target location, status and type. These two cells fed fire mission requests to the Joint Fires Cell via the Land Attack Weapons System (LAWS). This system allowed the JSC and ECOC to rapidly and efficiently pass fire mission request via a Local Area Network with a high degree of accuracy. This information was evaluated in the JFC to ensure it met Commander's Guidance and then a shooter was assigned to fire the mission. The mission information was transmitted via EHF satellite to a LAWS workstation on the shooter. LAWS was able to keep track of all pertinent data on the target, the units ashore and the fire support ships available so the decision-maker's situational awareness remained very high.

This hypothesis was partially maintained. The Predator sensor package in the manned Pelican vehicle proved invaluable in the urban environment. IR imagery did very little for the LAWS director. In comparison. JSTARS provided operationally substantial information in the urban environment but high traffic density made it difficult to distinguish contacts of interest. Sensor control is enhanced by bringing it close to the tactical center of gravity but integration across platforms is still difficult when choices between situational awareness and target prosectution must be made. Naval surface precision fires were rarely used as the weapon of choice in a city. A different weapons mix must found.

Lessons Learned

a) Sometimes FYI free text messages were interpreted as possible calls for fire. This can be worked out by establishing the fire support language to be used. The LAWS director did not fire the missions but had to waste time asking for clarification.
b) There was confusion over how many people and who had authorization to actually approve a fire mission. Everyone agreed this was because of the lack of understanding of what C2 relationships were and how information was supposed to flow.
c) There has never been a fire support overlay developed for any of the missions. This document should lay down basic fire support coordination measures.

In summary, while LAWS itself is a capable system, there exists a huge gap in what it can do and how we can exploit it with current tactics, techniques and procedures. Everything from TTPs to shipboard organization to comm links to mindsets needs to be changed to accommodate such a highly automated system. However if these can be changed very accurate, reliable, lethal fires could be delivered to battlefield while optimizing airspace via deconfliction.

2. Deconfliction

The use of long-range Naval weapons in these circumstances is currently constrained by the inability to efficiently deconflict the flight paths and trajectories and weapon effects of aircraft, UAVs and weapons. A more dynamic approach to deconflict could allow more efficient use of forces and more rapid striking of targets while avoiding fratricide. The deconfliction approaches can vary from decentralizes dynamic "get out of the way" to very centralized "permission granting systems. FBE-Echo will look at 4D (latitude, longitude, altitude and time) with a bubble of airspace around each object to minimize the amount of airspace closed to other weapons systems.

The Precision Engagement portion of the experiment also looked at how the myriad of missiles, unmanned aerial vehicles (UAVs), aircraft and shells can be orchestrated to minimize the risk of fratricide while optimizing the use of heavily used airspace. The Dynamic Allocation

Management System (DAMS) was linked to LAWS to provide rapid airspace deconfliction for incoming shells and missiles and aircraft transiting the area of operations.

Hypothesis: Dynamic deconfliction techniques can provide control in limited but diverse operations.
Measure 1: Targets served per period.
Measure 2: Time sensitive targets served while in engagement window.
Measure 3: Time for dynamic deconfliction vice permission with normal TTP.
Measure 4: % of battlespace available for dynamic assignment of fires.

Implementation The Dynamic Airspace Management Systems (DAMS) was used to predict trajectories and summarize status for time periods. DAMS was the major data source as well as the target requests and missions planned in LAWS.

The experiment was essentially a 'no-test" regarding this hypothesis.

Lessons Learned
a) There was some basic deconfliction between missions the JFC was firing and the P-3 and UAV were sensing. However, this was just because we could read their position data off the imagery. If it had been an actual military airspace it would have been significantly more cluttered. DAMS integration did not happen.
b) Although DAMS is supposed to do all deconfliction in an automated manner there should be one cell or watchstander tasked with this responsibility.

Dynamic deconfliction is a long-term solution with significant potential but is a long way from implementable.

V-4 FULL DIMENSION PROTECTION

Major Points

- Full Dimension Protection, as a concept operationalized through an FDP cell coordinated with a Harbor Defense Coordinator aboard an afloat MIUWU, and supported with a range of technologies, tactics and C2, successfully provided enhanced force protection in an asymmetric littoral environment against a range of threats.

- LINEBACKER concept proved its capability to provide JTAMD in concert with AADC role. Multiple constructed targets were successfully engaged, coordinated with the FDP cell and in an environment in which consequence management took on considerably greater importance due to presence of WMD. Excessive switching in and out of LINEBACKER/Tactical mode did present some hardware problems however, an area of further investigation.

- Synergy was demonstrated between technologies available to the FDP Watch Captain, and essentially proved the value of a network-centric environment in maintaining and using a

Common Operational Picture (COP). Specifically, combining near real time information of JSTARS, ADSI, UAV real time video feed, and targeting tools in LAWS created a responsive system in the FDP cell of immense variety. This variety was critical to the JTF capability to mount effective coordinated response, in a "Ring of Fire."

- Distributed Collaborative Planning (DCP) enhanced situational awareness between FDP cell on USS CORONADO, USS PORT ROYAL (AADC and LINEBACKER) and provided a reach-back capability to SMDBL and MOSC (Naval Postgraduate School also maintained a parallel COMPASS session during the experiment) that was essential in operational planning. COMPASS, as the DCP provider in the experiment was used daily as a means of coordinating planning. More importantly however, it was used effectively to establish a Defended Asset List (DAL) between the JTF provider of forces, and civil-military authorities. Construction of the DAL and the ability to engage in reevaluation in a dynamic environment was critical to defining force placements and real-time planning. Additional definition of DCP tools and protocols for their use and bandwidth to support them are areas requiring further consideration for additional experimentation.

- Joint coordination with AVENGER units added SHORAD to force protection. Combining within the network-centric environment in the JTF needs further development, in particular when combined with JTAMD and LINEBACKER. Coordination was developed through the course of the experiment, rather than prior understanding of interfaces and responsibilities.

- UAV added a superb capability to the FDP cell. Video feed directly to the watch team could be cognitively combined with additional information, e.g., ADSI fused LINK COP, surface picture from the HDC to the FDP and other technical sources to provide exceptional SA. This was proved to be particularly effective in FDP mission to find the WMD carrying vans, then respond to a range of potential developments. The UAV video feed included GPS data and cross-hair ranges that enabled the FDP cell to provide targeting information to JTF assets. In the final event, the FDP Watch Captain was able to engage the WMD vans using naval gunfire, based on UAV provided information. UAV operations need further refinement however, in the areas of C2 and command relationships. The platform was a demonstrated success, however the command relationships and C2 to support its use in a naval or joint operation and in a network-centric environment have not been developed. Tasking of the platform was often difficult and was a system with multiple internal conflicts.

- Low Slow Flyer (LSF) threat requires additional study. By chance, the HVU was pier-side next to a seaplane excursion operation. Multiple take-offs and landings by this aircraft made discriminating and reporting an actual LSF threat very difficult. The experiment was to include feed from the Western Area Defense Sector (WADS) radar, which was to be observed over a period of days to establish patterning behaviors for civilian aircraft. This feed was not available until the last day of the experiment however, and it is not clear that such patterning would have provided significant discrimination for evaluation. Another tactic was enacted by the FDP cell in lieu of WAS feed; CAST was used to determine most likely sites for LSF operation. JTF assets were then used to gather specific intelligence with regard to operations in these areas, which did in fact yield the OPFOR threat aircraft. Additional research needs to be conducted with regard to LSF threat and engagement, especially with regard to potential WMD capabilities.

- Use of the Joint Interface Control Officer (JICO) concept greatly enhanced the usefulness and reliability of the TADIL COP. The multi-link van (MLV) employed LINK tools that facilitated interface and maintained LINK operations. This operation, together with the Air Defense System Integrator (ADSI) maintained on USS CORONADO provided a combined LINK-11 and LINK-16 COP. As mentioned above, this COP was combined by the FDPCC within the network-centric set of tools provided in the FDP cell to create a range of actions as the dynamics of the tactical situation changed. JICO employment needs further development to include within the organic capabilities of the JTF.

- Use of visualization tools, such as STALKER enabled the FDP watch to make nearly immediate assessments of cruise missile launch and impact points. Coordination of actions between JTAMD, WMD analysis of engagement (consequence management of potential plume dispersions) and CIVMIL authorities provided a powerful system for near real-time COA determination. Further work needs to be considered however, for best means to provide coupling between these processes and technologies with WMD data; plume analysis from HPAC as part of the COA analysis vice post impact/engagement consequence management.

- Coordination with Precision Engagement, Land Attack Warfare System (LAWS) emerged as the experiment progressed. A LAWS terminal was included as part of the FDP suite, and a member of the FDP watch organization worked with the Precision Engagement cell to produce a working FDP-LAWS-PE fires team which demonstrated its effectiveness at sensing, identifying, targeting and pairing in numerous events. This process greatly decreased the potential TCT timeline of some events.

- Command relationships between FDP, the JTFC and joint operations need to be further defined. In this experiment there was considerable ambiguity in the precise distinction of the command relationships implied by FDP centralized capabilities and roles. Two examples for further definition are the development of FDP as the JTF moves from blue-water (CWC tactical environment) to littorals (FDP tactical environment). Consequences for battle-group organization and joint forces C2 are highly interrelated in this concept.

Concept

Mission Concept: If an expeditionary force is operating ashore, then the commander responsible for the defense of those forces should establish a Full Dimension Protection (FDP) cell to provide a single point for force defense.

Operations Methods: An FDP cell was formed under the CJTF and provided with technologies, procedures and personnel onboard USS CORONADO. A Joint Interface Control Officer (JICO) was assigned, with the objective to construct a defensive grid from TADIL data that would be observable at all levels between defense coordinators and expeditionary commanders. A C2 architecture was constructed that was to provide an analog of a network-centric environment in which all-source sensors and intelligence would be made accessible by CJTF and operational commanders to enable them to make tactical decisions in a time critical environment. An architecture was proposed in which civilian and military sensors would share data to construct a defensive grid, and was to include airport and harbor radar as part of the fused grid. A civil-military defense network was established to provide timely warning of asymmetric Ballistic Missile and air breathing threats capable of delivering a WMD.

Alongside the construction and implementation of various architectures, tactics, techniques and procedures (TTP's) were to be developed as an inductive process within the experiment. These included: the assessment of means to pattern civilian traffic patterns (space, air, land and sea) for discrimination of asymmetric threat against activity norms; use of LINEBACKER tactic to couple FDP to tracking of space and potential ballistic missile threats; TTP's for self-defense of high value assets (HVA) in confined battle-space; development of LINEBACKER TTP for defense of the CJTF DAL while simultaneously providing self-defense in an asymmetric environment; explore use of Naval control of Shipping (NCS) and MIUWU coordinated with civilian harbor defense authorities to deconflict surface engagements with asymmetric threats amongst civilian traffic.

System Solutions: <u>Technologies</u> (STALKER, EDGE, COMPASS, JSTARS, MSCT, LAWS, HPAC, ADSI, UAV), <u>organizational</u> (FDP cell, MIUWU-NCS, JICO, SHORAD-AVENGER, Precision Engagement, CIVMIL, WMD), <u>C2</u> (COMPASS, satellite, HF, UHF, VHF, land line, cellular comms, UNCLAS and classified web, GCCS/JMCIS), <u>data</u> (ADSI, JICO-TADIL), <u>TTP/tactical</u> (LINEBACKER, traffic patterning, NCS, UAV control).

<u>Summary</u>

JTAMD has been an important concept in FBEs to date. In FBE-Echo JTAMD was expanded conceptually to include defense against asymmetric Low Slow Flying (LSF) aircraft, theatre ballistic missiles and cruise missiles. The addition of AEGIS SPY-1 in a "Linebacker" mode combined with new sensors and technologies was to be tested in this experiment. A specific objective of the experiment was to explore the ability of the Expeditionary Force to make use of in-place civilian sensors to help establish a defensive grid. These sensors included airport and harbor radar and the supporting civilian communications system. UAVs, national assets and appropriate military systems such as the Air Force's JSTARS and Army AVENGER air defense units were also used in the network centric sensor and defensive grid. Fusion and control occurred aboard the CORONADO and the SLICE-boat embarked MIUWU as the asymmetric threat response cell. A Directed Energy Weapon (DEW) was also simulated as part of a C2 experiment include new technologies and develop tactics, techniques and procedures (TTPs) for their use.

In addition to maintaining an air picture with diverse sensor sources inputting data to an active defense, JTAMD included planning of attack operations and simulated operations and coordination with launch platforms, C2 nodes, missile stocks and infrastructure. Special software to support planning was installed on CORONADO and integrated fire missions passed to the Land Attack Warfare System (LAWS), to control weapon-target matching and mission cueing.

Hypotheses related to JTAMD in general were concerned with use of sensors to construct a sensor grid that would be sensitive to a high variety of asymmetric, air breathing and missile threats. At the same time, FDP was meant to integrate new technologies and consequent high data rates to create an effective defense and provide a C2 structure for other warfighting areas. As a result, JTAMD as part of FDP crossed most other warfighting areas important to the JTF.

Hypothesis (1): Addition of information from indigenous military/civilian systems (e.g., airport radar) can significantly improve the fused picture of air and surface showing conventional and asymmetric threats. Initial measures considered for this hypothesis:
Measure (1): Range at which a low, slow-flying threat can be detected and tracked.
Measure (2): Range at which asymmetric surface threats can be detected.
Measure (3): Warning time of a missile launch or range at which asymmetric cruise missile can be detected and engaged.
Measure (4): Fraction of population in affected area warned of asymmetric threat or WMD release.

To a large extent this area concerns adding civilian air track information and sophisticated processing to the force protection picture being generated in the Asymmetric Dominance areas described earlier. Measures (1) and (2) occurred again against the same threats and are treated in more detail there. Measure (3) assumes a cruise missile threat similar to that described below as well but extends into the track and engage portions of the event. A modeled event derived from this portion of the experiment is being prepared from electronically recorded data aboard the TAMD ship, detailed in collaborative logs maintained in the FDP cell and fused data at the Air Defense System Integrator (ADSI). An engine for this model is being constructed around Naval Simulation System (NSS).

Measure (4) involved the participation of a civil-military cell aboard CORONADO with the FDP cell. Although the hypothesis could be tested with respect to passing warnings to civilian authorities, the process of bringing together sensors fused at the FDP cell and models to provide data on launch points, distribution of WMD products and impact points required a system assessment. A collaborative event log and recordings of individual events was maintained for this purpose. To a large extent the success of this area should be assessed at two levels. The first is the ability to provide connectivity to the potential sources of information in an interoperable manner (national and JTF sensors). At the next level is the added value of this information to that provided by organic assets. Because of the qualitative nature of value added, a questionnaire was administered by NPS students (brought aboard to capture data) to gather significant observations by participants after significant events.

The Air Defense System Integrator (ADSI) fused together all the tracks from the Link 11 and Link 16 tactical data links. This database was preserved for later analysis of specific events. For example, simulated missile tracks were injected from SPAWAR in San Diego, which were included in link data reported to the FDP cell via ADSI. These tracks became the basis of

TAMD intercept problems, which included plume analysis and impact point analysis for delivery to the civil-military cell for further action. Further analysis of these track data is ongoing, using data reduction of the very dense Link reporting systems and positional data fed to NSS.

The hypothesis was partially confirmed in that the LINEBAKER multiple-AEGIS ship configuration allowed remote tracking, reporting and simulated engagement of simulated air/missile threats to the city. Combined with the fused link data, modeling technologies and C2 aboard the flagship, the JTAMD system improved situational awareness of such threats and allowed warning to be provided to civil defense authorities within one minute.

Army AVENGER air defense units were likewise able to provide direct support to ground elements while maintaining Link 16 connectivity, ensuring the same COP with Aegis units so that the JTAMD umbrella was stretched over the littoral. Additionally, participants noted that JSTARS data provided valuable tracking data on boats and vehicles in the city.

A Joint Interface Control Officer (JICO) function was established to maintain continuity of the joint data link picture to the COP. Some difficulties were recognized, as connectivity was tenuous and further investigation of sensor management/ integration is indicated. Because much of the link was maintained as a serial feed (phone line vice electromagnetic data feed), span of control was stretched without regard for realistic C3 difficulties so that FDP was not tested with regard to C3 capabilities.

Activities within the FDP cell focused on the actions of an FDP Cell Commander (FDPCC). Once MSEL events began, the FDPCC directed watch-standers to accomplish tasks necessary to complete the event. Two watch-standers, a Surface Defense Coordinator (SDC) and an Air Defense Coordinator (ADC) monitored the Surface and Air voice nets and controlled surface and air threat coordination while the FDPCC monitored the Command net and controlled JTF assets using technologies within the FDP cell. Other positions in the cell included contractors to operate and manage various contributing technologies: EDGE, ADSI, LAWS, STALKER and COMPASS.

The experiment demonstrated the fusion potential for the many sensors dedicated to FDP. Working relationships between technologies and their value added within the FDP cell was not well formulated prior to events. However, what was demonstrated was that centralization of many sensors, predictive and targeting tools placed in an operations room enhanced situational awareness of decision-makers and provided a common operational picture. Future experiments of this concept should be designed around more specifically focused hypotheses (or narrower concepts). TTPs constructed to improve independent system performance as part of the FDP decision making structure might also prove useful in determining useful and valid measures of effectiveness and performance.

As an example, an important FDP capability involved "patterning" civilian air traffic over a period of days to create a picture from which to later subtract anomalous behavior of what might be an asymmetric threat (low slow flyer). When Western Air Defense System (WADS) data was fused with the JTF Link (military air picture), there was a significant problem with clutter. Without clear TTPs to determine how this information could be processed and used to enhance the COP to provide value-added data, it was difficult for the watch team to use the information presented. In addition, measures of effectiveness were limited at this level to determining whether the data system supported construction of the picture, but not the effectiveness of system components. By conducting this first experiment however, it will be possible to construct measures of effectiveness and performance, and focus concepts to be tested in experimental design.

At the point in analysis of FDP and TAMD in FBE-Echo the data supports system level assessment. Reconstruction of individual events using modeling and simulation tools will reveal much about system interactions and provide additional insights. This event level analysis is being pursued at present.

V-5 INFORMATION SUPERIORITY

Major Points

This concept dealt with the hardware and system aspects of information superiority. Thus, it does not overlap with Joint Experimentation initiatives. Information concepts that do overlap, such as the Common Operation Picture, are distributed through the other concepts.

Concept

Even though no information is extracted from this concept to meet Joint Experimentation needs, we list the following for the sake of completeness.

Mission Concept: Provide sufficient and reliable networking of communication information in the battlespace.

Operations Method: Naval Forces operating in the littoral will have access to signals previously unavailable to afloat sensors. The ability to monitor and report levels of activity about communications paths will enable command action to restore or enable connectivity and flow of information.

System Solutions: Naval Communication Network

Technical Solutions: SNIFFER

V-6 CASUALTY MANAGEMENT AND CIVIL MILITARY OPERATIONS

Major Points

- DARPA One Way Multi-Lingual Interview System shows promising utility.

- The Center of Excellence in Disaster Management and Humanitarian Assistance (COE) using proprietary software SoftRisk enabled interface with CMOC's similar information system based on Lotus Notes with the emergency response network.

- WMD identification, real time METOC data, and real time feed of WMD indications/warnings/analysis are required for command management of WMD

Concept

Casualty Management (CM): Network- centric Casualty Management would transform medical care for civilian and military casualties from a localized process, to a distributed process. In the localized process, each echelon does its best for the casualties presented to it. In the distributed process care of casualties is planned, monitored, and distributed to the best location for that casualty. The status of each echelon and ability to re-distribute the case- load and medical resources would all be taken in to consideration. New tools for casualty estimation, planning, casualty interviewing, event monitoring, clinical reference, patient status reporting and in-transit visibility can provide needed capabilities.

Mission Concept: Provide coordination between the military force and the domestic Civil-Military authorities to provide managed response to weapons of mass destruction as well as managing casualties in the operations area.

Operations Method: Operate in an urban littoral environment while conducting civil-military operations of a medical nature and provide military use of civilian medical facilities.

System Solutions: Medical Virtual Workspace; Casualty prediction and logistics models; Collaborative Medical Logbook; Multi-lingual Interview System; Incident Watchboard

Hardware Solutions: DOW; MAT; FORCAS; SHIPCAS; CASEVAC

Summary

CASUALTY MANAGEMENT (CM)
Most CM, as opposed to CMO, occurred later during Phases 2 & 3. Only the DARPA One-Way or Multi-Lingual Interview System (MLSl) was slated for use in Echo. It is a small, portable device for asking non-English speaking casualties about their injuries. The system is a notebook size computer translator capable of translating specific phrases from English into a variety of languages, including Spanish, German, Korean, French and Arabic. The use of the device by medical corpsmen during the Urban Warrior Experiments was to test the system in a real environment, primarily to learn from the experience so that improvements could be made to make it an operationally useful instrument. At this time, the DOW is in the bench-top instrumentation stage. The developers, Dragonfly, Inc., and the DARPA contract monitor, Mr. Ace Sarich, is fully aware of its current limitations.

In the Monterey operation the MLSI was available and several civilian Korean-speaking mock-casualties were brought to the field medical site after a mock explosion. Unfortunately one of the two trained corpsmen was unable to come ashore because of bad weather. This overloaded the other corpsman who was unable to take the time after the explosion and consequent casualty gathering to use the MLSI. The exercise was terminated pre-maturely soon after the casualties were gathered, again because of the worry about helo operations in the fog.

As a result of difficulties in the Monterey operation with media getting in the way, civilians were not allowed in the playbox in the Alameda operations. As a result only limited use of the MLSI was possible there as well because of the need for support from Mr. Sarich.

NPS observers were able to use the DOW in an office environment and observe its performance in the field. Interviews with five Navy corpsmen were conducted after field use in Oak Knoll. Based on these interviews, the DARPA One Way Multi-lingual Interview System is not yet ready for field operational, but does show promising utility.

The primary difficulty was the large number of times the user was forced to repeat the English phrase before the unit was able to match it to the foreign language equivalent. Although the system worked well in a laboratory environment the battlefield environment was apparently too noisy. This is particularly a concern in time stressed situations. Noise suppression is being worked on and should be incorporated into the next trial.

It is likely that the MLSI should be considered a "no-test" in FBE Echo. However medical personnel looked forward to a time when a true two-way translation device will be available for use in refugee treatment situations.

As an adjunct to the FBE-Echo CM, an evaluation of three casualty prediction / management tools was performed: Ship Casualty Projection System (SHIPCAS), Ground Forces Casualty Forecasting System (FORCAS) and Medical Analysis Tool (MAT). The purpose of these tools is assist the medical planners in preparing the medical annex Q to the OPLANS. The tools were tested by stepping through the beginnings of the OPLAN preparation.

MAT requires a basic daily rate of occurrence of casualties as an input. SHIPCAS and FORCAS provide such a rate as their output. Both of the latter are based on historical rates of losses. On the average ships in the Pacific received .3 hits per hundred days engaged in WW!I, for example. The wisdom of planning for such Iow occurrences, even adjusted for more modem circumstances, is very debatable. It would seem more appropriate to base medical planning for an operation on the possibility that one or more ships will be hit, rather than on some long-term average. Neither model had a modem interface and SHIPCAS in particular was difficult to use (translating actual ships into the SHIPCAS categories was difficult) and even dangerous in that the visibility of assumptions and inputs is not maintained for ease of checking. The treatment of uncertainty in the two models differed and was not obvious to the user. An alternative to the use of these models is the existence of a nominal rate of casualties per day that has at least the virtue of transparency. FORCAS and SHIPCAS were given Iow ratings by the assessment personnel.

The Medical Analysis Tool translates the gross casualty rates into demand for resources at any medical support structure that is also input by the planner. The level of detail requires an in depth analysis of medical operations but that is appropriate to the subjects employing the tool. In the opinion of the medical planner involved, it was stated that the outputs were consistent with other estimates for Kernel Blitz. The software has a modem interface and has suitable documentation.

Visibility into the calculation is not complete but satisfactory. The assessment personnel rated near the top of the scale and about twice as high as the other two models.

During the USMC CM activities an excellent document "Humanitarian Assistance and Disaster Relief" was encountered. It is one of a series of products of the USMC Warfighting Lab as a quick turn-around digest that is distributed widely within the Corps. A similar product from MBC might be appropriate.

Civil-Military Operations (CMO)
The vision for civil-military operations of a medical nature is to develop a to share information and resources to responding to emergencies. This would allow the military to make maximum use of civilian medical facilities and to provide emergency military aid to civilian first-responders to avoid secondary casualties.

In the Echo phase of Kernel Blitz Prime, CMO was the focus of the efforts that we were asked to assess. These occurred largely in the JMC and in the CMOC space aboard the USS Coronado, part of the Sea-based Battle Lab. A two-day experiment with the California Governor's Office of Emergency Services (OES) in Oakland was performed. The Center of Excellence in Disaster Management and Humanitarian Assistance (COE) provide expertise to the OES's incident reporting system to the CMOC's similar information system based on Lotus Notes. This system, developed by Jim Rogers of COE, utilizes a piece of proprietary software named SoftRisk. The JMC/CMOC was able to receive the California emergency reports via SoftRisk by the end of the exercise via Honolulu, the COE headquarters. In addition UHF, HF and phone circuits were planned.

During the first day communications were not functioning, partly due to a power supply failure. During a scripted terrorist incident near the Bay Bridge, a predicted chorine gas plume was obtained by the JMC from the Lawrence Livermore Laboratory and passed to the OES in about ten minutes by fax, which was difficult to read. Later it was discovered that this plume differed greatly from another plume obtained for the same scripted incident in the VVMD cell onboard the USS Coronado. It is possible that the two different weather sources used were a part of the discrepancy. This incident pointed out the necessity for full communication capabilities and knowledge of the tools being used for sharing predictions with the civilian community.

On the second day the communications were vastly improved and the CMOC responded (provided messages concerning notional support) to about a dozen requests for aid from the OES during the five-hour experiment. Actual airborne imagery was requested and obtained and delivered at the conclusion of the experiment, for example. At the end of the five-hour exercise period the OES personnel came to the Coronado and an after-action review was conducted using the CMOC Group Systems decision support system.. A large amount of information was collected to serve as the basis for future doctrine development. The participants completed a questionnaire in which they rated all aspects except "All appropriate parties were included in the planning" with an average of "Agree". This points out the need for even more broad coordination of actions with the multitudinous civilian authorities. This exercise was focused on the early hours of the incident before FBI and FEMA points of contact would be in place.

Both the OES and the CMOC personnel expressed great satisfaction with the experiment which was a significant step in the potential direct real-time cooperation for actual emergencies before other command relationships can be established through FEMA, etc.

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VI. RESULTS SPECIFIC TO JOINT EXPERIMENTATION

As was discussed in the Process section, we have reassessed the Echo results to address the JE concepts and issues. This has necessitated combining some results, discarding some, and taking some as presented for Echo. The planned key to extracting the JE pertinent information was Table 2, the overlap matrix. A complicating factor was modification of Echo concepts, as noted previously. This leaves one in somewhat of a quandary: whether to use the overlap matrix, the JE issues and Echo hypotheses statements, examination of Echo results and their applicability to JE initiatives, or some combination to extract the JE appropriate results.

We have chosen the latter approach for this report. The rationale is straightforward. Echo was not designed to address JE concepts. The overlap matrix can be a guide for where to find the needed information. If the Data Archiving scheme were fully implemented, we would be able to pull JE "strings" through all of the data and produce a large number of results. Lacking that, we have pulled results from the Major Points produced for each Echo concept.

It is obvious that there may be many more points in the Echo data that apply to JE concepts than those labeled Major. Such results are not included in this report. In this preliminary study to determine if FBEs can be mined to obtain JE results, mining from the Major Points is sufficient to establish the viability of the process and to obtain a quality set of results.

Following are subsections that address each JE concept. In each are listed the JE issues and the corresponding Echo hypotheses from the overlap matrix. These are included because they present a rationale for which hypotheses to examine for pertinent results. This is followed by the Major Points judged to be applicable.

The Major Points are labeled in accordance with their FBE concept in the following way:

AT-x	Asymmetric Threat,
NCASW-x	Netcentric Antisubmarine Warfare,
PE-x	Precision engagement,
FDP-x	Full Dimension Protection,
CM/CMO-x	Casualty Management and Civil Military Operations,

where x is the number of the Point. In order to reduce the number of words in this section, we have abbreviated some of the Major Point statements. For the full texts see Section IV.

VI-1 ATTACK OPERATIONS AGAINST CRITICAL MOBILE TARGETS

Issue-1: What levels of command are authorized to engage?
Issue-2: How is the OODA loop enabled to operate more quickly?

<u>Linkage from Overlap Matrix</u>
FBE Maritime Dominance - Countering Asymmetric Threat
H6: The sensor network and contact management capabilities of the ASW network provides an improved ability to finger-print and conduct all source overt and

covert tracking of high interest white shipping in support of Area defense against covertly armed shipping, counter proliferation ops, counter narcotics or other counter smuggling ops.

H7: Networked multi-sensor surveillance and response forces in layered defense can counter night attacks on the HVU by anti-ship missiles launched from a truck which exits a known holding area and proceeds to a launching area in the hills above the harbor.

FBE Precision Engagement/Ring of Fire- National Assets and UAV for Fires in Support of Forces Ashore in Urban Canyons

H1: Navy UAVs in conjunction with other assets can provide effective warning and supporting fires to USMC urban operations against enemy actions beaches /streets/buildings, enemy vehicular movements, enemy infiltration in urban neighborhoods, enemy WMD in industrial area, night urban targeting, vehicular target of interest, interdiction of USMC operating areas, fixed targets of WMD interest, China Lake range targets, targets related to WMD vignette beyond Concord.

FBE Precision Engagement/Ring of Fire - ELB Experimentation

H1: Coordination of a variety of sensors with the attacking aircraft can provide mission-essential information to the cockpit for strikes within the window of a time-critical targets and also aid the pilot in finding and hitting the target.

FBE Precision Engagement/Ring of Fire - SACCEX

H1: Digital information from LASER/GPS range-finders will allow effective GPS -guided NSFS at ranges of 18K yards using the LAWS-AFATDS-BCS linkage.

<u>FBE Major Points Addressing These Concept Issues</u>

AT-1 Embarkation of the MIUW Van extended organic and inorganic sensor range and allowed it to be used in the Littoral Zone of Interest without having to establish a secure rear area for MIUWU protection

AT-2 Utilization of the UAV for detection, identification, and tracking had remarkable value. High quality imagery of mobile targets was almost continuously available to the Harbor Defense Commander , Full Dimension Protection Cell and others. A combat swimmer was detected by the UAV while at altitude.

NCASW-2 Reliable networked communications are essential for Distributed Collaborative planning (DCP) in NCASW

NCASW-3 Common tactical decision aids and common understanding of the DCP process enhance the update of situational awareness required for NCASW

PE-2 Deconfliction requires further investigation. DAMS was not successfully electronically interfaced to LAWS. Full implementation of algorithmic procedural deconfliction in LAWS may yield improvement over current methods and be more efficient than DAMS. Any deconfliction system requires an adequate visualization tool to be useful. No methods currently address latency issues.

FDP-1 Full Dimension Protection, as a concept operationalized through an FDP cell coordinated with a Harbor Defense Coordinator aboard an afloat MIUWU, and supported with a range of technologies, tactics and C2, successfully provided enhanced force protection in an asymmetric littoral environment against a range of threats.

FDP-3 Synergy was demonstrated between technologies available to the FDP Watch Captain, and essentially proved the value of a network-centric environment in maintaining and using a Common Operational Picture (COP).

FDP-4 Distributed Collaborative Planning (DCP) enhanced situational awareness between FDP cell on USS CORONADO, USS PORT ROYAL (AADC and LINEBACKER) and provided a reach-back capability to SMDBL and MOSC.

FDP-5 Joint coordination with AVENGER units added SHORAD to force protection. Combining within the network-centric environment in the JTF needs further development, in particular when combined with JTAMD and LINEBACKER.

FDP-6 UAV added a superb capability to the FDP cell. Video feed directly to the watch team could be cognitively combined with additional information, e.g., ADSI fused LINK COP, surface picture from the HDC to the FDP and other technical sources to provide exceptional SA.

FDP-8 Use of the Joint Interface Control Officer (JICO) concept greatly enhanced the usefulness and reliability of the TADIL COP. The multi-link van (MLV) employed LINK tools that facilitated interface and maintained LINK operations.

FDP-9 Use of visualization tools, such as STALKER enabled the FDP watch to make nearly immediate assessments of cruise missile launch and impact points. Coordination of actions between JTAMD, WMD analysis of engagement (consequence management of potential plume dispersions) and CIVMIL authorities provided a powerful system for near real-time COA determination.

FDP-10 Coordination with Precision Engagement, Land Attack Warfare System (LAWS) emerged as the experiment progressed. A LAWS terminal was included as part of the FDP suite, and a member of the FDP watch organization worked with the Precision Engagement cell to produce a working FDP-LAWS-PE fires team which demonstrated its effectiveness at sensing, identifying, targeting and pairing in numerous events. This process greatly decreased the potential TCT timeline of some events.

FDP-11 Command relationships between FDP, the JTFC and joint operations need to be further defined. In this experiment there was considerable ambiguity in the precise distinction of the command relationships implied by FDP centralized capabilities and roles.

VI-2 FUTURE COLLABORATIVE INFORMATION ENVIRONMENT

Issue-1: What is our capability to support the creation of a database of near real time information concerning events in the AOR?
Issue-2: What is our capability to support the establishment of timeliness criteria (<1 hour) for recognition and inclusion of info in the database?

Linkage from Overlap Matrix

FBE Maritime Dominance - Countering Asymmetric Threat

H8: Intel prep of the battlespace, advanced sensors, and networked control of CG PSU by MIUWU will allow more effective positioning and employment of the PSU against the variety of asymmetric threats.

FBE Maritime Dominance - Network Centric Undersea Warfare

H2: The use of identical, hi-fidelity models and associated databases by all ASW participants improves the overall understanding of the overall search plan and individual sensor performance. Additionally, the use of a common model allows "drill-down" into the factors affecting performance.

H5: The sensor network and contact management capabilities of the ASW network provides an improved ability to "finger-print' and conduct all source overt or covert tracking of high interest WHITE shipping.

FBE Precision Engagement/Ring of Fire - National Assets and UAV for Fires in Support of Forces Ashore in Urban Canyons

H1: Navy UAVs in conjunction with other assets can provide effective warning and supporting fires to USMC urban operations against enemy actions beaches /streets/buildings, enemy vehicular movements, enemy infiltration in urban neighborhoods, enemy WMD in industrial area, night urban targeting, vehicular target of interest, interdiction of USMC operating areas, fixed targets of WMD interest, China Lake range targets, targets related to WMD vignette beyond Concord.

FBE Full Dimension Protection

H1: The addition of information from civilian in-place systems can significantly improve the fused picture of air and surface conventional and asymmetric threats.

FBE Civil Military Operations - Consequence Management of Toxic Releases

H1: There are effective civil-military responses to the two toxic releases.

FBE Major Points Addressing These Concept Issues

AT-1 Embarkation of the MIUW Van extended organic and inorganic sensor range and allowed it to be used in the Littoral Zone of Interest without having to establish a secure rear area for MIUWU protection

AT-2 Utilization of the UAV for detection, identification, and tracking had remarkable value. High quality imagery of mobile targets was almost continuously available to the Harbor

Defense Commander , Full Dimension Protection Cell and others. A combat swimmer was detected by the UAV while at altitude.

NCASW-1 NCASW increased force situational awareness through distributed advance search plans

NCASW-2 Reliable networked communications are essential for Distributed Collaborative planning (DCP) in NCASW

NCASW-3 Common tactical decision aids and common understanding of the DCP process enhance the update of situational awareness required for NCASW

PE-2 Deconfliction requires further investigation. DAMS was not successfully electronically interfaced to LAWS. Full implementation of algorithmic procedural deconfliction in LAWS may yield improvement over current methods and be more efficient than DAMS. Any deconfliction system requires an adequate visualization tool to be useful. No methods currently address latency issues.

FDP-1 Full Dimension Protection, as a concept operationalized through an FDP cell coordinated with a Harbor Defense Coordinator aboard an afloat MIUWU, and supported with a range of technologies, tactics and C2, successfully provided enhanced force protection in an asymmetric littoral environment against a range of threats.

FDP-3 Synergy was demonstrated between technologies available to the FDP Watch Captain, and essentially proved the value of a network-centric environment in maintaining and using a Common Operational Picture (COP

FDP-4 Distributed Collaborative Planning (DCP) enhanced situational awareness between FDP cell on USS CORONADO, USS PORT ROYAL (AADC and LINEBACKER) and provided a reach-back capability to SMDBL and MOSC.

FDP-6 UAV added a superb capability to the FDP cell. Video feed directly to the watch team could be cognitively combined with additional information, e.g., ADSI fused LINK COP, surface picture from the HDC to the FDP and other technical sources to provide exceptional SA.

FDP-8 Use of the Joint Interface Control Officer (JICO) concept greatly enhanced the usefulness and reliability of the TADIL COP. The multi-link van (MLV) employed LINK tools that facilitated interface and maintained LINK operations.

FDP-9 Use of visualization tools, such as STALKER enabled the FDP watch to make nearly immediate assessments of cruise missile launch and impact points. Coordination of actions between JTAMD, WMD analysis of engagement (consequence management of potential plume dispersions) and CIVMIL authorities provided a powerful system for near real-time COA determination.

FDP-10 Coordination with Precision Engagement, Land Attack Warfare System (LAWS) emerged as the experiment progressed. A LAWS terminal was included as part of the FDP suite, and a member of the FDP watch organization worked with the Precision Engagement cell to produce a working FDP-LAWS-PE fires team which demonstrated its effectiveness at sensing, identifying, targeting and pairing in numerous events. This process greatly decreased the potential TCT timeline of some events.

FDP-11 Command relationships between FDP, the JTFC and joint operations need to be further defined. In this experiment there was considerable ambiguity in the precise distinction of the command relationships implied by FDP centralized capabilities and roles.

VI-3 JOINT CONTINGENCY FORCE OPERATIONS

Issue: What technology(s) improved the survivability and supportability of early entry forces?

<u>Linkage from Overlap Matrix</u>
FBE Maritime Dominance - Countering Asymmetric Threat
H1: Combat swimmers can be detected by Mobile Inshore Undersea Warfare Unit (MIUWU) and other swimmer detection systems and countered by coordinated ops of the Port Security Unit
H2: Attached mines can be located more quickly by hand-held sonar.
H3: Networked multi-sensor surveillance and response forces in layered defense can counter asymmetric small boat attacks.
H4: Networked multi-sensor surveillance and response forces in layered defense can counter attacks from personal watercraft.
H5: Networked multi-sensor surveillance and response forces in layered defense can counter night attacks on anchored HVU by covert rubber boat with Sea Shadow drop-off.
H6: Networked multisensor surveillance and advanced detection and management systems can mitigate effects of asymmetric WMD attacks from low, slow flying aircraft.
H7: Networked multi-sensor surveillance and response forces in layered defense can counter night attacks on the HVU by anti-ship missiles launched from a truck which exits a known holding area and proceeds to a launching area in the hills above the harbor.
H8: Intel prep of the battlespace, advanced sensors, and networked control of CG PSU by MIUWU will allow more effective positioning and employment of the PSU against the variety of asymmetric threats.

FBE Maritime Dominance - Network Centric Undersea Warfare
H2: The use of identical, hi-fidelity models and associated databases by all ASW participants improves the overall understanding of the overall search plan and individual sensor performance. Additionally, the use of a common model allows "drill-down" into the factors affecting performance.

H5: The sensor network and contact management capabilities of the ASW network provides an improved ability to "finger-pring' and conduct all source overt or covert tracking of high interest WHITE shipping.

FBE Precision Engagement/Ring of Fire- National Assets and UAV for Fires in Support of Forces Ashore in Urban Canyons

H1: Navy UAVs in conjunction with other assets can provide effective warning and supporting fires to USMC urban operations against enemy actions beaches /streets/buildings, enemy vehicular movements, enemy infiltration in urban neighborhoods, enemy WMD in industrial area, night urban targeting, vehicular target of interest, interdiction of USMC operating areas, fixed targets of WMD interest, China Lake range targets, targets related to WMD vignette beyond Concord.

FBE Precision Engagement/Ring of Fire - Airspace Deconfliction

H1: Dynamic deconfliction techniques can provide control in limited but diverse operations.

FBE Precision Engagement/Ring of Fire - ELB Experimentation

H1: Coordination of a variety of sensors with the attacking aircraft can provide mission-essential information to the cockpit for strikes within the window of a time-critical targets and also aid the pilot in finding and hitting the target.

FBE Precision Engagement/Ring of Fire - SACCEX Experimentation

H1: Digital information from LASER/GPS range-finders will allow effective GPS -guided NSFS at ranges of 18K yards using the LAWS-AFATDS-BCS linkage.

FBE Full Dimension Protection

H1: The addition of information from civilian in-place systems can significantly improve the fused picture of air and surface conventional and asymmetric threats.

<u>FBE Major Points Addressing These Concept Issues</u>

AT-1 Embarkation of the MIUW Van extended organic and inorganic sensor range and allowed it to be used in the Littoral Zone of Interest without having to establish a secure rear area for MIUWU protection

AT-2 Utilization of the UAV for detection, identification, and tracking had remarkable value. High quality imagery of mobile targets was almost continuously available to the Harbor Defense Commander , Full Dimension Protection Cell and others. A combat swimmer was detected by the UAV while at altitude.

AT-3 Changes in tactics that compensates for arc and range of fire and improved identification methods are needed to prevent fratricide of HVA defenders and take into account possible collateral damage both over water and ashore.

NCASW-3 Common tactical decision aids and common understanding of the DCP process enhance the update of situational awareness required for NCASW

PE-2 Deconfliction requires further investigation. DAMS was not successfully electronically interfaced to LAWS. Full implementation of algorithmic procedural deconfliction in LAWS may yield improvement over current methods and be more efficient than DAMS. Any deconfliction system requires an adequate visualization tool to be useful. No methods currently address latency issues.

PE-3 Naval Surface Precision Fires weapons currently in use or programmed are not useful in the Urban Canyons.

FDP-1 Full Dimension Protection, as a concept operationalized through an FDP cell coordinated with a Harbor Defense Coordinator aboard an afloat MIUWU, and supported with a range of technologies, tactics and C2, successfully provided enhanced force protection in an asymmetric littoral environment against a range of threats.

FDP-2 LINEBACKER concept proved its capability to provide JTAMD in concert with AADC role. Multiple constructed targets were successfully engaged, coordinated with the FDP cell and in an environment in which consequence management took on considerably greater importance due to presence of WMD.

FDP-3 Synergy was demonstrated between technologies available to the FDP Watch Captain, and essentially proved the value of a network-centric environment in maintaining and using a Common Operational Picture (COP).

FDP-4 Distributed Collaborative Planning (DCP) enhanced situational awareness between FDP cell on USS CORONADO, USS PORT ROYAL (AADC and LINEBACKER) and provided a reach-back capability to SMDBL and MOSC.

FDP-5 Joint coordination with AVENGER units added SHORAD to force protection. Combining within the network-centric environment in the JTF needs further development, in particular when combined with JTAMD and LINEBACKER.

FDP-7 Low Slow Flyer (LSF) threat requires additional study. By chance, the HVU was pier-side next to a seaplane excursion operation. Multiple take-offs and landings by this aircraft made discriminating and reporting an actual LSF threat very difficult.

FDP-9 Use of visualization tools, such as STALKER enabled the FDP watch to make nearly immediate assessments of cruise missile launch and impact points. Coordination of actions between JTAMD, WMD analysis of engagement (consequence management of potential plume dispersions) and CIVMIL authorities provided a powerful system for near real-time COA determination.

FDP-10 Coordination with Precision Engagement, Land Attack Warfare System (LAWS) emerged as the experiment progressed. A LAWS terminal was included as part of the FDP suite, and a member of the FDP watch organization worked with the Precision Engagement cell to produce a working FDP-LAWS-PE fires team which demonstrated its effectiveness at sensing, identifying, targeting and pairing in numerous events. This process greatly decreased the potential TCT timeline of some events.

FDP-11 Command relationships between FDP, the JTFC and joint operations need to be further defined. In this experiment there was considerable ambiguity in the precise distinction of the command relationships implied by FDP centralized capabilities and roles.

CM/CMO-3 WMD identification, real time METOC data, and real time feed of WMD indications/warnings/analysis are required for command management of WMD

VI-4 COMMON RELEVANT OPERATIONAL PICTURE

Issue-1: How do Marine Corps systems contribute to the COP?
Issue-2: What is the most efficient balance of "push" and "pull" dissemination?
Issue-3: How will each Service's common tactical picture interface with the COP?
Issue-5: How can the common operational picture realistically accommodate information sharing with NGOs and PVOs?

<u>Linkage from Overlap Matrix</u>

FBE Maritime Dominance - Countering Asymmetric Threat

H1: Combat swimmers can be detected by Mobile Inshore Undersea Warfare Unit (MIUWU) and other swimmer detection systems and countered by coordinated ops of the Port Security Unit
H3: Networked multi-sensor surveillance and response forces in layered defense can counter asymmetric small boat attacks.
H4: Networked multi-sensor surveillance and response forces in layered defense can counter attacks from personal watercraft.
H5: Networked multi-sensor surveillance and response forces in layered defense can counter night attacks on anchored HVU by covert rubber boat with Sea Shadow drop-off.
H6: Networked multisensor surveillance and advanced detection and management systems can mitigate effects of asymmetric WMD attacks from low, slow flying aircraft.
H7: Networked multi-sensor surveillance and response forces in layered defense can counter night attacks on the HVU by anti-ship missiles launched from a truck which exits a known holding area and proceeds to a launching area in the hills above the harbor.
H8: Intel prep of the battlespace, advanced sensors, and networked control of CG PSU by MIUWU will allow more effective positioning and employment of the PSU against the variety of asymmetric threats.

FBE Maritime Dominance - Network Centric Undersea Warfare

H1: A collaboratively developed ASW search plan improves overall search effectiveness.
H2: The use of identical, hi-fidelity models and associated databases by all ASW participants improves the overall understanding of the overall

search plan and individual sensor performance. Additionally, the use of a common model allows "drill-down" into the factors affecting performance.

H3: Time integration of the tactical undersea picture provides additional significant information for all ASW echelons compared to the current real-time tactical picture alone.

H5: The sensor network and contact management capabilities of the ASW network provides an improved ability to "finger-print' and conduct all source overt or covert tracking of high interest WHITE shipping.

FBE Precision Engagement/Ring of Fire - National Assets and UAV for Fires in Support of Forces Ashore in Urban Canyons

H1: Navy UAVs in conjunction with other assets can provide effective warning and supporting fires to USMC urban operations against enemy actions beaches /streets/buildings, enemy vehicular movements, enemy infiltration in urban neighborhoods, enemy WMD in industrial area, night urban targeting, vehicular target of interest, interdiction of USMC operating areas, fixed targets of WMD interest, China Lake range targets, targets related to WMD vignette beyond Concord.

FBE Full Dimension Protection

H1: The addition of information from civilian in-place systems can significantly improve the fused picture of air and surface conventional and asymmetric threats.

FBE Civil Military Operations-Virtual Information Center

H1: A Virtual Work Space can improve the coordination between the JMC and the CMOC.

FBE Civil Military Operations-Doctrine

H1: Doctrine for managing a domestic Civil Military operation through the CMOC can be developed.

FBE Major Points Addressing These Concept Issues

AT-2 Utilization of the UAV for detection, identification, and tracking had remarkable value. High quality imagery of mobile targets was almost continuously available to the Harbor Defense Commander , Full Dimension Protection Cell and others. A combat swimmer was detected by the UAV while at altitude.

AT-3 Changes in tactics that compensates for arc and range of fire and improved identification methods are needed to prevent fratricide of HVA defenders and take into account possible collateral damage both over water and ashore.

NCASW-1 NCASW increased force situational awareness through distributed advance search plans

NCASW-3 Common tactical decision aids and common understanding of the DCP process enhance the update of situational awareness required for NCASW

PE-2 Deconfliction requires further investigation. DAMS was not successfully electronically interfaced to LAWS. Full implementation of algorithmic procedural deconfliction in LAWS may yield improvement over current methods and be more efficient than DAMS. Any deconfliction system requires an adequate visualization tool to be useful. No methods currently address latency issues.

FDP-2 LINEBACKER concept proved its capability to provide JTAMD in concert with AADC role. Multiple constructed targets were successfully engaged, coordinated with the FDP cell and in an environment in which consequence management took on considerably greater importance due to presence of WMD.

FDP-3 Synergy was demonstrated between technologies available to the FDP Watch Captain, and essentially proved the value of a network-centric environment in maintaining and using a Common Operational Picture (COP).

FDP-4 Distributed Collaborative Planning (DCP) enhanced situational awareness between FDP cell on USS CORONADO, USS PORT ROYAL (AADC and LINEBACKER) and provided a reach-back capability to SMDBL and MOSC.

FDP-6 UAV added a superb capability to the FDP cell. Video feed directly to the watch team could be cognitively combined with additional information, e.g., ADSI fused LINK COP, surface picture from the HDC to the FDP and other technical sources to provide exceptional SA.

FDP-8 Use of the Joint Interface Control Officer (JICO) concept greatly enhanced the usefulness and reliability of the TADIL COP. The multi-link van (MLV) employed LINK tools that facilitated interface and maintained LINK operations.

FDP-9 Use of visualization tools, such as STALKER enabled the FDP watch to make nearly immediate assessments of cruise missile launch and impact points. Coordination of actions between JTAMD, WMD analysis of engagement (consequence management of potential plume dispersions) and CIVMIL authorities provided a powerful system for near real-time COA determination.

FDP-10 Coordination with Precision Engagement, Land Attack Warfare System (LAWS) emerged as the experiment progressed. A LAWS terminal was included as part of the FDP suite, and a member of the FDP watch organization worked with the Precision Engagement cell to produce a working FDP-LAWS-PE fires team which demonstrated its effectiveness at sensing, identifying, targeting and pairing in numerous events. This process greatly decreased the potential TCT timeline of some events.

CM/CMO-2 The Center of Excellence in Disaster Management and Humanitarian Assistance (COE) using proprietary software SoftRisk enabled interface with CMOC's similar information system based on Lotus Notes with the emergency response network.

CM/CMO-3 WMD identification, real time METOC data, and real time feed of WMD indications/warnings/analysis are required for command management of WMD

VI-5 ADAPTIVE JOINT COMMAND AND CONTROL

Issue-1: Will the degree of connectivity, bandwidth, and knowledge available tempt senior commanders to usurp lower-level decisions and micro-manage?
Issue-2: Assuming a new joint force architecture is a means with the potential to accelerate info flow and decision making, will it also increase the span of control, thus altering command relationships and organizations?
Issue-3: Will the advances in technology allow for the elimination of an echelon(s) of command, their associated headquarters, and support requirements?
Issue-4: What is the optimum balance of information push/pull for the 21st century?

Linkage from Overlap Matrix

FBE Maritime Dominance - Network Centric Undersea Warfare

H1: A collaboratively developed ASW search plan improves overall search effectiveness.
H2: The use of identical, hi-fidelity models and associated databases by all ASW participants improves the overall understanding of the overall search plan and individual sensor performance. Additionally, the use of a common model allows "drill-down" into the factors affecting performance.
H3: Time integration of the tactical undersea picture provides additional significant information for all ASW echelons compared to the current real-time tactical picture alone.
H5: The sensor network and contact management capabilities of the ASW network provides an improved ability to “finger-pring’ and conduct all source overt or covert tracking of high interest WHITE shipping.

FBE Precision Engagement/Ring of Fire - National Assets and UAV for Fires in Support of Forces Ashore in Urban Canyons

H1: Navy UAVs in conjunction with other assets can provide effective warning and supporting fires to USMC urban operations against enemy actions beaches /streets/buildings, enemy vehicular movements, enemy infiltration in urban neighborhoods, enemy WMD in industrial area, night urban targeting, vehicular target of interest, interdiction of USMC operating areas, fixed targets of WMD interest, China Lake range targets, targets related to WMD vignette beyond Concord.

FBE Precision Engagement/Ring of Fire - ELB Experimentation

H1: Coordination of a variety of sensors with the attacking aircraft can provide mission-essential information to the cockpit for strikes within the window of a time-critical targets and also aid the pilot in finding and hitting the target.

FBE Naval Command and Control

H1: A combined Blue-Green ECOC will enhance collaboration between the staffs and allow better understanding of the commander's intent, a more complete perception of the total battlespace and more rapid staff action preparation.

FBE Precision Engagement/Ring of Fire - Airspace Deconfliction

H1: Dynamic deconfliction techniques can provide control in limited but diverse operations..

FBE Civil Military Operations - Virtual Work Space
H1: A Virtual Work Space can improve the coordination between the JMC and the CMOC.

FBE Naval Command and Control
H1: A combined Blue-Green ECOC will enhance collaboration between the staffs and allow better understanding of the commander's intent, a more complete perception of the total battlespace and more rapid staff action preparation.

FBE Maritime Dominance - Countering Asymmetric Threat
H3: Networked multi-sensor surveillance and response forces in layered defense can counter asymmetric small boat attacks.
H8: Intel prep of the battlespace, advanced sensors, and networked control of CG PSU by MIUWU will allow more effective positioning and employment of the PSU against the variety of asymmetric threats.

<u>FBE Major Points Addressing These Concept Issues</u>

NCASW-1 NCASW increased force situational awareness through distributed advance search plans

NCASW-2 Reliable networked communications are essential for Distributed Collaborative planning (DCP) in NCASW

FDP-1 Full Dimension Protection, as a concept operationalized through an FDP cell coordinated with a Harbor Defense Coordinator aboard an afloat MIUWU, and supported with a range of technologies, tactics and C2, successfully provided enhanced force protection in an asymmetric littoral environment against a range of threats.

FDP-2 LINEBACKER concept proved its capability to provide JTAMD in concert with AADC role. Multiple constructed targets were successfully engaged, coordinated with the FDP cell and in an environment in which consequence management took on considerably greater importance due to presence of WMD.

FDP-3 Synergy was demonstrated between technologies available to the FDP Watch Captain, and essentially proved the value of a network-centric environment in maintaining and using a Common Operational Picture (COP).

FDP-4 Distributed Collaborative Planning (DCP) enhanced situational awareness between FDP cell on USS CORONADO, USS PORT ROYAL (AADC and LINEBACKER) and provided a reach-back capability to SMDBL and MOSC.

FDP-5 Joint coordination with AVENGER units added SHORAD to force protection. Combining within the network-centric environment in the JTF needs further development, in particular when combined with JTAMD and LINEBACKER.

FDP-6 UAV added a superb capability to the FDP cell. Video feed directly to the watch team could be cognitively combined with additional information, e.g., ADSI fused LINK COP, surface picture from the HDC to the FDP and other technical sources to provide exceptional SA.

FDP-8 Use of the Joint Interface Control Officer (JICO) concept greatly enhanced the usefulness and reliability of the TADIL COP. The multi-link van (MLV) employed LINK tools that facilitated interface and maintained LINK operations.

FDP-9 Use of visualization tools, such as STALKER enabled the FDP watch to make nearly immediate assessments of cruise missile launch and impact points. Coordination of actions between JTAMD, WMD analysis of engagement (consequence management of potential plume dispersions) and CIVMIL authorities provided a powerful system for near real-time COA determination.

FDP-10 Coordination with Precision Engagement, Land Attack Warfare System (LAWS) emerged as the experiment progressed. A LAWS terminal was included as part of the FDP suite, and a member of the FDP watch organization worked with the Precision Engagement cell to produce a working FDP-LAWS-PE fires team which demonstrated its effectiveness at sensing, identifying, targeting and pairing in numerous events. This process greatly decreased the potential TCT timeline of some events.

FDP-11 Command relationships between FDP, the JTFC and joint operations need to be further defined. In this experiment there was considerable ambiguity in the precise distinction of the command relationships implied by FDP centralized capabilities and roles. Two examples for further definition are the development of FDP as the JTF moves from blue-water (CWC tactical environment) to littorals (FDP tactical environment). Consequences for battle-group organization and joint forces C2 are highly interrelated in this concept.

CM/CMO-2 The Center of Excellence in Disaster Management and Humanitarian Assistance (COE) using proprietary software SoftRisk enabled interface with CMOC's similar information system based on Lotus Notes with the emergency response network.

VI-6 INTEROPERABLE COMBAT ID

Issue: How is CID of troops and equipment provided to prevent fratricide in an urban setting?

<u>Linkage from Overlap Matrix</u>
FBE Maritime Dominance - Countering Asymmetric Threat
H6: Networked multisensor surveillance and advanced detection and management systems can mitigate effects of asymmetric WMD attacks from low, slow flying aircraft.
H8: Intel prep of the battlespace, advanced sensors, and networked control of CG PSU by MIUWU will allow more effective positioning and

employment of the PSU against the variety of asymmetric threats.

FBE Maritime Dominance - Network Centric Undersea Warfare

H4: The undersea tactical picture provides sufficiently timely positional and operational information for blue force submarines to safely enable dynamic weapons exclusion zones around blue force submarines.

H5: The sensor network and contact management capabilities of the ASW network provides an improved ability to "finger-pring' and conduct all source overt or covert tracking of high interest WHITE shipping.

FBE Precision Engagement/Ring of Fire - National Assets and UAV for Fires in Support of Forces Ashore in Urban Canyons

H1: Navy UAVs in conjunction with other assets can provide effective warning and supporting fires to USMC urban operations against enemy actions beaches /streets/buildings, enemy vehicular movements, enemy infiltration in urban neighborhoods, enemy WMD in industrial area, night urban targeting, vehicular target of interest, interdiction of USMC operating areas, fixed targets of WMD interest, China Lake range targets, targets related to WMD vignette beyond Concord.

FBE Precision Engagement/Ring of Fire - Airspace Deconfliction

H1: Dynamic deconfliction techniques can provide control in limited but diverse operations.

FBE Naval Command and Control

H1: A combined Blue-Green ECOC will enhance collaboration between the staffs and allow better understanding of the commander's intent, a more complete perception of the total battlespace and more rapid staff action preparation.

<u>FBE Major Points Addressing These Concept Issues</u>

AT-3 Changes in tactics that compensates for arc and range of fire and improved identification methods are needed to prevent fratricide of HVA defenders and take into account possible collateral damage both over water and ashore.

PE-2 Deconfliction requires further investigation. DAMS was not successfully electronically interfaced to LAWS. Full implementation of algorithmic procedural deconfliction in LAWS may yield improvement over current methods and be more efficient than DAMS. Any deconfliction system requires an adequate visualization tool to be useful. No methods currently address latency issues.

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SectionVII. PROCESS SUMMARY

The purpose of this project was to design and test a methodology to obtain results from FBEs that address Joint Experimentation concepts and to obtain some illustrative results. This has been done successfully. This summary addresses the project to set up the leveraging process, not the concept results. Those results are contained in the bulk of the report and are summarized in the Executive Summary.

The following points and recommendations show the current status of the project.

1. Fleet Battle Experiments provide a significant amount of information that addresses Joint Experimentation concepts. This is expected since both focus on command and control issues.

2. It is not possible to find a one-to-one link between FBE and JE concepts. Data obtained to address an FBE concept applies to several JE concepts, and information pertinent to a single JE concept is found in several FBE concept results.

3. The many-to-many linkage between FBE results and JE concepts applies within the FBE process itself. Data obtained for one concept readily applies to another. This is because many the concepts are explored in a single days events, causing the need to sort data in multiple ways.

4. Evolution of FBE concepts, and the experimental plans, makes it difficult to determine before the conclusion of the experiment which results apply to JE concepts. It would simplify this process if greater priority were given to JE needs during the FBE planning process. This might appear overly restrictive to FBE planning, but it shouldn't be because of the overlap between the basic ideas behind both sets of concepts.

5. Addressing JE needs will be much easier once the Data Archival and Retrieval process described in Section III is implemented.

6. It would be useful to the JE process to take the FBE results that are associated with a particular JE concept and refine them. There is a significant amount of information associated with each concept, and it could be processed so as to produce insights both into the concept and into fruitful means for further experimentation. This conceive-experiment-modify-iterate again process should be undertaken as part of every experiment cycle.

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Appendix I. FBE-ECHO REPORT EXECUTIVE SUMMARY

Background

The Fleet Battle Experiments (FBE) are CNO-initiated series of operational experiments for the purpose of examining emerging systems, technologies and concepts. The Maritime Battle Center (MBC) of the new Navy Warfare Development Command (NWDC) is the CNO's agent for planning and implementing these experiments in conjunction with the numbered Fleets. FBE-E is the fifth in the series and is under the operational sponsorship of Commander Third Fleet (COMTHIRDFLT) in San Diego. The Naval Postgraduate School (NPS) performed assessment for FBE-E during March and April 1999.

Concepts and Experiment Approach

NPS has performed assessments for several Joint Warrior Interoperability demonstrations (JWIDs) and routinely for the ONR Adaptable Architecture for Command and Control (A2C2) laboratory experiments. NPS personnel were also involved in the All-Service Combat Identification Evaluation Team field tests in 1995 & 1996. The Modular C2 Evaluation Structure (MCES) is a tool developed at NPS in conjunction with the Military Operations Research Society (MORS) for stepping through quantitative assessments that has applicability for FBE-E. NPS has conceptually applied the MCES in helping to define measures to gauge the success of each of the major areas of FBE-E.

Although the FBEs are labeled Experiments, they are not laboratory but operational experiments or, more exactly, explorations of new concepts, technologies, and processes. In FBEs to date there have seldom been opportunities for experimental replication (several runs under controlled conditions) or control groups that constitute the standard case or experimental designs that systematically vary the very large number of factors in the operations. Usually the base case or standard is simply the "usual process and results". Perhaps more important than whether the specific experimental processes worked in this FBE, are the insights into how they can be made better for the next FBE.

Major Results

We present here the major results that have been extracted from the larger body of results, with no attempt to organize them with respect to initiatives.

- Embarkation of the MIUW Van extended organic and inorganic sensor range and allowed it to be used in the Littoral Zone of Interest without having to establish a secure rear area for MIUWU protection

- Utilization of the UAV for detection, identification, and tracking had remarkable value. High quality imagery of mobile targets was almost continuously available to the Harbor Defense

Commander, Full Dimension Protection Cell and others. A combat swimmer was detected by the UAV while at altitude.

- Changes in tactics that compensates for arc and range of fire and improved identification methods are needed to prevent fratricide of HVA defenders and take into account possible collateral damage both over water and ashore.

- NCASW increased force situational awareness through distributed advance search plans

- Reliable networked communications are essential for Distributed Collaborative planning (DCP) in NCASW

- Common tactical decision aids and common understanding of the DCP process enhance the update of situational awareness required for NCASW

- Laws demonstrated flexibility and ease of use. While the system was by no means fully exploited, it performed well for the functions utilized during this experiment.

- Deconfliction requires further investigation. DAMS was not successfully electronically interfaced to LAWS. Full implementation of algorithmic procedural deconfliction in LAWS may yield improvement over current methods and be more efficient than DAMS. Any deconfliction system requires an adequate visualization tool to be useful. No methods currently address latency issues.

- Naval Surface Precision Fires weapons currently in use or programmed are not useful in the Urban Canyons.

- NCASW increased force situational awareness through distributed advance search plans

- Reliable networked communications are essential for Distributed Collaborative planning (DCP) in NCASW

- Common tactical decision aids and common understanding of the DCP process are enhance the update of situational awareness required for NCASW

- DARPA One Way Multi-Lingual Interview System shows promising utility.

- The Center of Excellence in Disaster Management and Humanitarian Assistance (COE) using proprietary software SoftRisk enabled interface with CMOC's similar information system based on Lotus Notes with the emergency response network.

- WMD identification, real time METOC data, and real time feed of WMD indications/warnings/analysis are required for command management of WMD

Experimentation Issues

The process of naval concept development is supported by experimentation, partially in the FBEs, but also in games and LOEs. In order to perform even operational experiments, an analytical framework, which identifies the issues to be addressed and the possible indications of the results, is required. Therefore FBE's have identified hypotheses and measures of effectiveness. Although to a large extent these have not been testable, it is largely because the treatments (new systems to be introduced) and the conditions (the scenario and fleet actions) have not been able to be accomplished in the actual FBE. Experimentation requires an experimental test bed. In FBE-Echo circumstances did not allow dedicated experimentation along the lines planned. Moreover many of the planned new systems were either not available or not serviceable in the environment. Future FBEs must be protected from these factors if the results are to be complete and credible.

Recommendations

Further testing of MIUW Units on mobile platforms is indicated. Improved communications and sensor architectures and network connectivity require further study.

Methods and or tactics for protection of HVA that minimize collateral damage and guard against fratricide need to be developed and evaluated.

Fully integrate UAV control into the command network to enhance dynamic and broad use of a valuable tactical sensor.

Further experimentation on network centric antisubmarine warfare to include integration into the full dimension protection concept and also to include tracking of white shipping.

Deconfliction methods integrated into the weapons network that are visual and simply displayed should be developed and evaluated in future experiments.

Command and Control policy and architectures for sensors and sensor coverage need to be developed and evaluated. Develop and use an automated method of cueing of changes in command and control posture and sensor allocation. This could facilitate timely and dynamic reallocation of sensors in the grid to adequately response to changing threat levels in the battlespace.

Precision strike weapons need to be developed and evaluated for their use profiles and potential for collateral damage.

EXPERIMENTATION

Analysis Methodology

FBE Echo was defined by high-level goals from which lower level or more detailed operational concepts called themes were developed. Using these themes, hypotheses and measures were enumerated. This conceptual framework contributed to the construction of a data-capture plan and follow-on evaluation.

In general, when dealing with complex systems, system complexity increases as the focus moves from the abstract concepts to the system components. One impact of this complexity continuum is a necessity for the data gathering and analysis processes to become similarly complex. FBE Echo provided an opportunity to determine the scope of data gathering and evaluation requirements and to study how they might be refined for implementation in future experiments.

The Naval Postgraduate School effort for data collection in FBE Echo was an experiment within an experiment. The effort was geared to integrate the development of the assessment plan and the development of the data capture plan with the development of the experiment plan.

The complexity of the experiment planning process however as well as the dynamics of the changes to execution plans resulted in mismatch between scheduled events and the data collection plan. In some cases assets were required for experimental uses that incapacitated scheduled data capture without the knowledge of the assessment team until well after the fact.

These experiences highlight the need for using an autonomous data capture scheme coupled with a data archival system and knowledge management methodologies to maximize support for updating analysis of initiatives. A single experiment does not produce the quantity of data for a full analysis of any one initiative. There is much useful data both qualitative and quantitative that can be gleaned from an experiment. NPS is in the process of developing the data archive capability to capitalize on the incremental addition of data and knowledge management \methodologies for subsequent initiative analysis update.

Data Capture Technology and Methods

An outcome of Fleet Battle Experiments is that the design of data capture methods and technologies are improved as the experiments are executed. What will accomplish the data capture task in any given experiment is the result of something learned in a previous experiment, or part of a well-established methodology taken from the domains of military exercise data collection. However, complex experiments, such as FBE Echo require multiple data capture methods.

Quantitative (electronic) and qualitative data were gathered in the course of FBE Echo. Quantitative data was recorded to establish “ground truth” in asymmetric interactions, which could then be used for modeling analysis and as part of further development of simulations. Two principal means employed to gather this data were GPS (Global Positioning System) and ADSI. (Air Defense System Integrator).

Portable (hand-held) GPS units were procured (approximately 20) for use by asymmetric forces, JTF PSU (Port Security Unit) boats and by two rental trucks posing as mobile SCUD-type missile launch platforms. The GPS units were equipped with a detachable memory on which GPS positions were recorded for a prescribed time step. A difficulty with this technology was that as the time-step was shortened, available memory for the platform’s track was used more quickly, resulting in shorter times between change-out of memory. Detachable memory was downloaded from each GPS unit onto a laptop, for use in reconstructing a particular unit's track.

ADSI is a LINK integrator device, which fuses together inputs from LINK-11 and LINK-16 and presents a common operational (LINK) picture to the JTF Commander. USS CORONOADO was equipped with ADSI in FBE Echo, and the system output was an input to the COP (Common Operational Picture) in the Full Dimension Protection cell. ADSI has a data-recording feature that records LINK reports and stores them for later retrieval and data reduction. This database was retrieved post-exercise for analysis and reconstruction.

Qualitative data was gathered through multiple means and instruments. Each experiment pillar was defined around a set of concepts stated as hypotheses. Many of these hypotheses required observational data, questionnaires or debriefings. In addition, collaborative logs were collected where used. For example, COMPASS was used as a distributed collaborative planning tool between the Full Dimension Protection (FDP) cell on CORONADO and other units in the experiment. The log of these communications was collected at the end of the experiment. Similarly, an electronic log was maintained in the FDP cell and provided an excellent source of information for post-experiment analysis.

Questionnaires were developed relevant to specific participants in specific types of events, and filled out at the end of each event. These were used extensively in asymmetric events as a means to debrief OPFOR participants. Questionnaires were also constructed for various watch-stander roles throughout the experiment, but were less effective at gathering information.

Debriefings of participants in asymmetric attack, WMD targeting events, UAV support and other cells were particularly valuable in establishing the context of the experiment and contributed a great deal to the insights gained in the experiment.

Data Archiving, Modeling and Knowledge Management

There is a tendency to treat major experiments as independent events, which produce final results for a specific set of questions. But, FBE concepts are broad and require a succession of experiments before obtaining final answers. We expect experimentation to lead to modification of many aspects of the operations concepts being tested over time. Concepts, procedures, systems, etc., will all be in evolution. This makes it important to have an analysis system, which is robust and complete in MOEs, parameters produced, and information archiving.

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Appendix II. LIST OF ACRONYMS

AADC	Area Air Defense Coordination
ADC	Air Defense Coordinator
ADSI	Air Defense System Integrator
AFATDS	Advanced Field Artillery Tactical Data System
AOR	Area of Responsibility
ASW	Anti-Submarine Warfare
AVENGER	Army air defense system
CG	Carrier Group
CID	Combat Identification
CIVMIL	Civil/Military
CJTF	Commander Joint Task Force
CM	Casualty Management
CMOC	Civil/Military Operations Center
COE	Center of Excellence
COMPASS	A Navy information reach-back system
COP	Common Operating Picture
CROP	Common Relevant Operating Picture
CWC	Combined Warfare Commander
DAL	Defended Asset List
DAMS	Dynamic Airspace Management System
DARPA	Defense Advanced Research Project Agency
DCP	Distributed Collaborative Planning
ECOC	Enhanced Combat Operations Center
EOD	Explosive Ordnance disposal
FBE	Fleet Battle Experiment
FDP	Full Dimension Protection
FDPCC	Full Dimension Protection Cell Commander
FORCAS	Ground Forces Casualty System
GCCS	Global Command and Control System
GPS	Global Positioning System
HDC	Harbor Defense Commander
HPAC	Hazard Prediction Analysis Capability
HVU	High Value Unit
IBU	Inshore Boat Unit
ISAR	Inverse Synthetic Aperture Radar
JAO	Joint Area of Operations
JEZ	Joint Engagement Zone
JE	Joint Experimentation
JFC	Joint Fires Cell
JICO	Joint Interface Control Officer
JMCIS	Joint Maritime Communication and Information System
JSC	Joint Strike Center
JSTARS	Joint Surveillance, Targeting, and Recognizance System

JTAMD	Joint Theater Air and Missile Defense
JTF	Joint Task Force
LAWS	Land Attack Warfare System
LINEBACKER	A concept for use of an Aegis ship for area air defense
LOE	Limited Objective Experiment
LPMP	Launch Profile Mission Planning
LSF	Low Slow Flyer
MAT	Medical Analysis Tool
METOC	Meteorology/Oceanography
MIUWU	Mobile Inshore Undersea Warfare Unit
MLSI	Multi-Lingual Interview System
MLV	Multi-Link Van
MSEL	Master Scenario Event List
NCASW	Network-Centric Anti-Submarine Warfare
NCS	Net Control Station
NF	Naval Fires
NGO	Non-Government Organizations
NSFS	Naval Surface Fires System
OES	Office of Emergency Services
OPFOR	Opposition Forces
PE	Precision Engagement
PSU	Port Security Unit
PVO	Private Volunteer Organizations
SDC	Surface Defense Coordinator
SHIPCAS	Ship Casualty Projection System
SHORAD	Shore Based Air Defense
SNIFFER	Airborne contaminant hazard sensing system
STALKER	Unmanned air vehicle
TADIL	Tactical Data Link
TCT	Time Critical Targets
TTP	Tactics, Techniques, and Procedures
UAV	Unmanned Air Vehicle
WADS	Western Air Defense Sector
WMD	Weapons of Mass Destruction
WeCAN	Web Centric ASW Network

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